



US009469380B2

(12) **United States Patent**  
**Watarai et al.**

(10) **Patent No.:** **US 9,469,380 B2**  
(45) **Date of Patent:** **\*Oct. 18, 2016**

(54) **BICYCLE CONTROL DEVICE**

G05G 1/04; B62L 3/023; B62L 3/02; B62L 3/026

(71) Applicant: **Shimano Inc.**, Sakai, Osaka (JP)

See application file for complete search history.

(72) Inventors: **Etsuyoshi Watarai**, Osaka (JP);  
**Osamu Kariyama**, Osaka (JP);  
**Tatsuya Matsushita**, Osaka (JP);  
**Masahiro Nakakura**, Osaka (JP)

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,175,648 A 11/1979 Sule  
4,391,353 A 7/1983 Mathauser

(Continued)

(73) Assignee: **Shimano Inc.**, Osaka (JP)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 203 days.

This patent is subject to a terminal disclaimer.

FOREIGN PATENT DOCUMENTS

EP 2308750 A1 4/2011  
EP 2615020 A2 \* 7/2013 ..... B62L 3/023  
WO 2007025984 A1 3/2007

OTHER PUBLICATIONS

(21) Appl. No.: **14/094,718**

Machine translation of WO 2007/025984.\*

(22) Filed: **Dec. 2, 2013**

(Continued)

(65) **Prior Publication Data**

US 2014/0174243 A1 Jun. 26, 2014

*Primary Examiner* — Adam D Rogers

(74) *Attorney, Agent, or Firm* — Global IP Counselors

(30) **Foreign Application Priority Data**

Dec. 26, 2012 (JP) ..... 2012-007805 U

(57) **ABSTRACT**

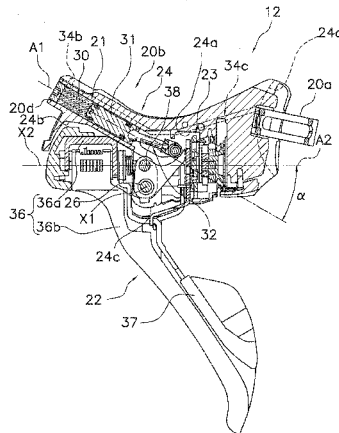
(51) **Int. Cl.**  
**B62M 25/04** (2006.01)  
**B62K 23/06** (2006.01)  
(Continued)

A bicycle control device includes a housing member, a control lever member, a shift-operating mechanism and a hydraulic fluid pressure generator. The housing member has an attachment part for attachment to a handlebar, and a grip part extending longitudinally between first and second ends of the grip part. The shift-operating mechanism includes a cable take-up member rotatably mounted around a cable take-up axis. The cable take-up member has a control cable attachment part that is configured to be coupled to a shifting device by a control cable. The hydraulic fluid pressure generator has a cylinder and a piston movably that is disposed within the cylinder by movement of the control lever member to generate fluid pressure for controlling a braking device. The cylinder defines a cylinder axis that forms an angle of greater than or equal to 20° and less than or equal to 50° with the cable take-up axis.

(52) **U.S. Cl.**  
CPC ..... **B62M 25/04** (2013.01); **B62K 23/06** (2013.01); **B62M 25/00** (2013.01); **B62L 3/023** (2013.01); **Y10T 74/20438** (2015.01)

(58) **Field of Classification Search**  
CPC ..... B62K 23/00; B62K 23/02; B62K 23/06; Y10T 74/20438; Y10T 74/20414; Y10T 74/20444; Y10T 74/2045; Y10T 74/20456; Y10T 74/20462; Y10T 74/20396; Y10T 74/2042; B62M 2025/006; B62M 25/045; B62M 25/04; B62M 25/02; B62M 25/00;

**12 Claims, 17 Drawing Sheets**



- |              |      |         |                 |                         |
|--------------|------|---------|-----------------|-------------------------|
| 4,665,803    | A    | 5/1987  | Mathauser       |                         |
| 4,921,081    | A    | 5/1990  | Chilcote        |                         |
| 7,540,147    | B2   | 6/2009  | Takizawa et al. |                         |
| 7,650,813    | B2   | 1/2010  | Tsumiyama       |                         |
| 8,201,670    | B2   | 6/2012  | Tetsuka et al.  |                         |
| 8,448,762    | B2 * | 5/2013  | Hirose .....    | B60T 11/16<br>188/24.11 |
| 8,464,844    | B2   | 6/2013  | Jordan          |                         |
| 2006/0260427 | A1 * | 11/2006 | Tsumiyama ..... | B62M 25/04<br>74/502.2  |
| 2010/0199798 | A1   | 8/2010  | Uno             |                         |
| 2012/0240715 | A1   | 9/2012  | Tsai            |                         |
| 2013/0255239 | A1   | 10/2013 | Miki            |                         |

- |              |      |         |                 |                         |
|--------------|------|---------|-----------------|-------------------------|
| 2014/0174234 | A1 * | 6/2014  | Watarai .....   | B62M 25/04<br>74/473.11 |
| 2014/0174235 | A1 * | 6/2014  | Watarai .....   | B62M 25/04<br>74/473.14 |
| 2014/0174236 | A1 * | 6/2014  | Nakakura .....  | B62M 25/08<br>74/473.14 |
| 2014/0174237 | A1 * | 6/2014  | Watarai .....   | B62L 3/023<br>74/489    |
| 2014/0174244 | A1 * | 6/2014  | Watarai .....   | B62M 25/00<br>74/502.2  |
| 2015/0274252 | A1 * | 10/2015 | Nishino .....   | B62L 3/023<br>92/161    |
| 2016/0129966 | A1 * | 5/2016  | Meggiolan ..... | B62L 3/023<br>74/491    |

European Search Report of corresponding EP Application No. 13 19 8132.6 dated Apr. 28, 2014.

\* cited by examiner

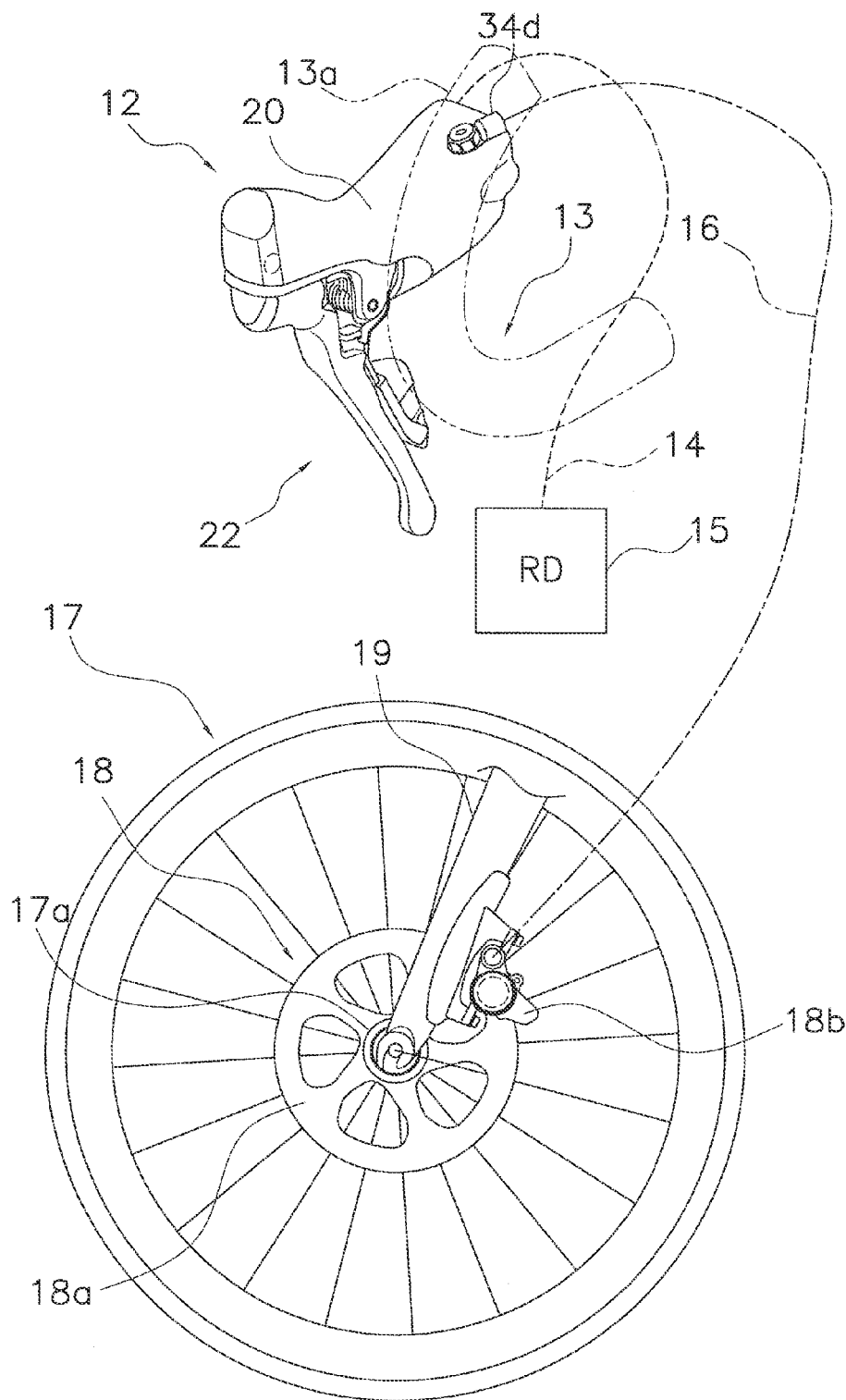


FIG. 1

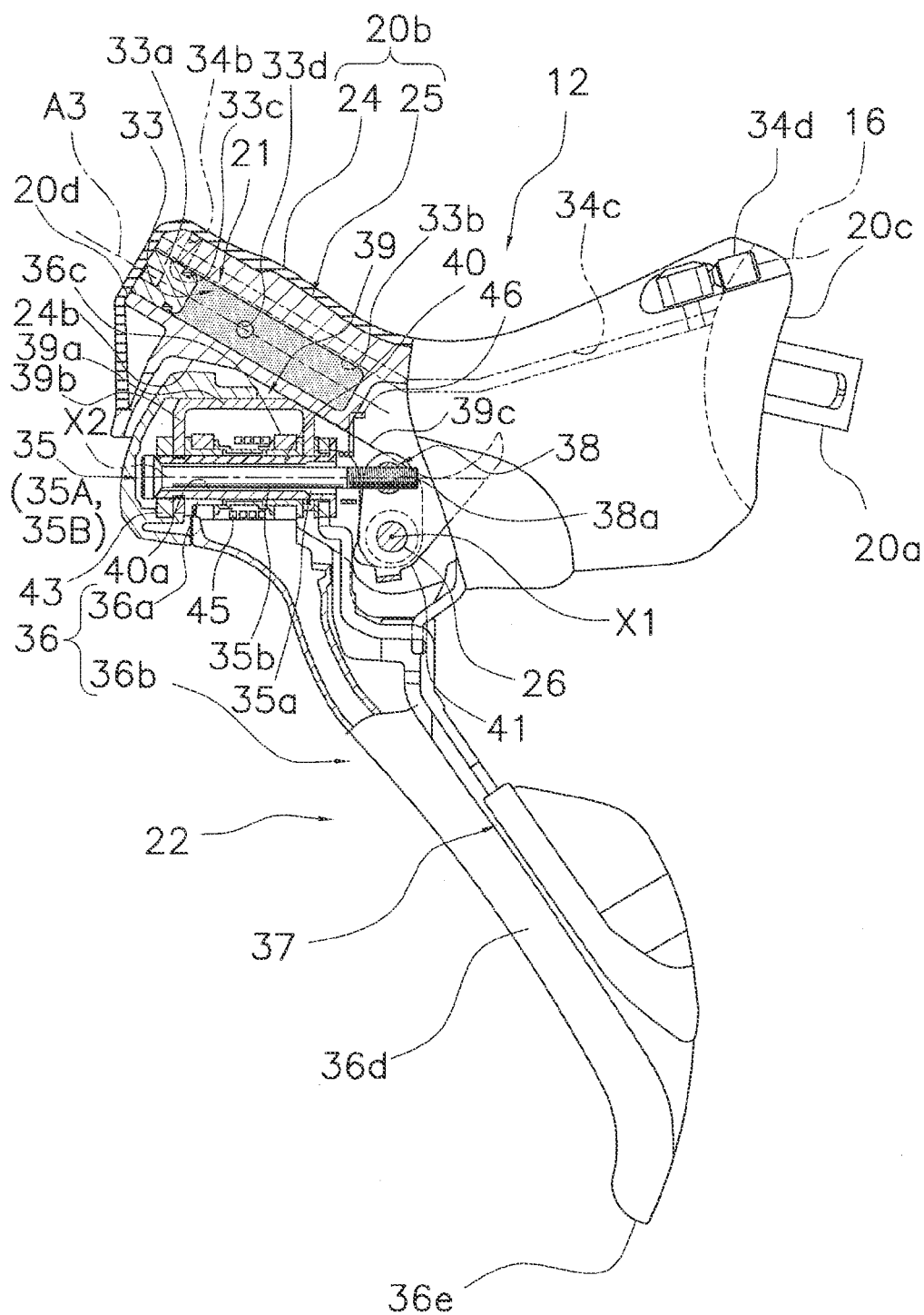


FIG. 2

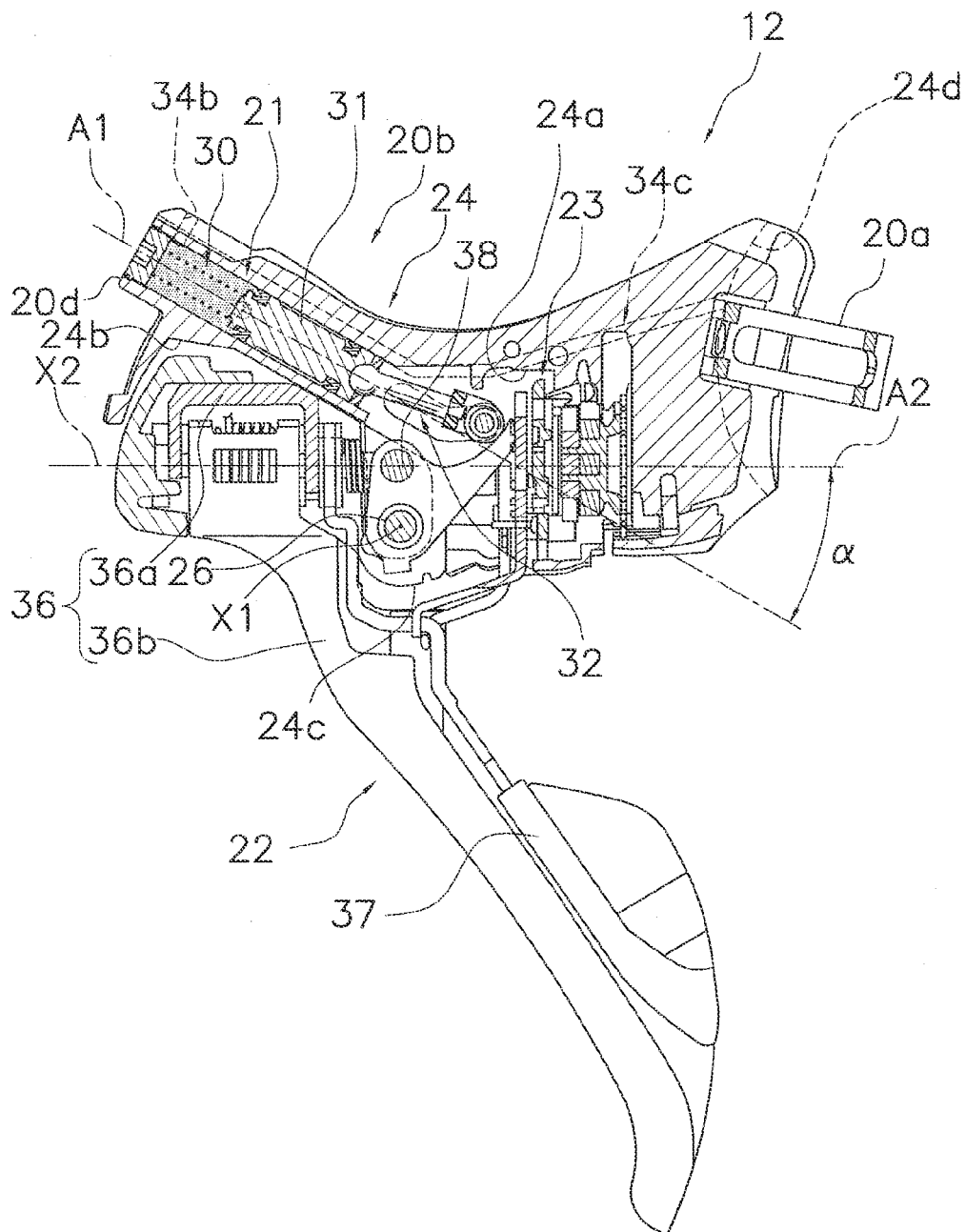


FIG. 3

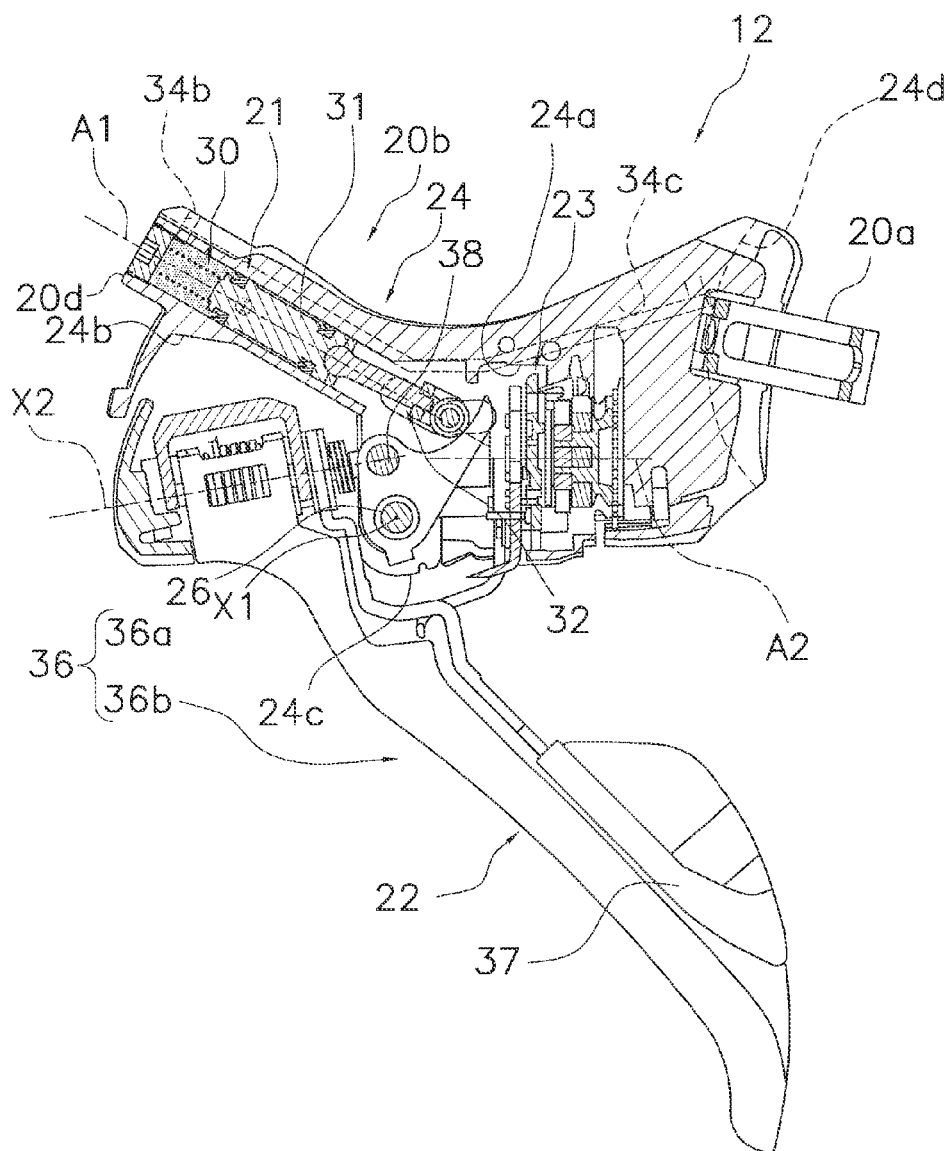


FIG. 4

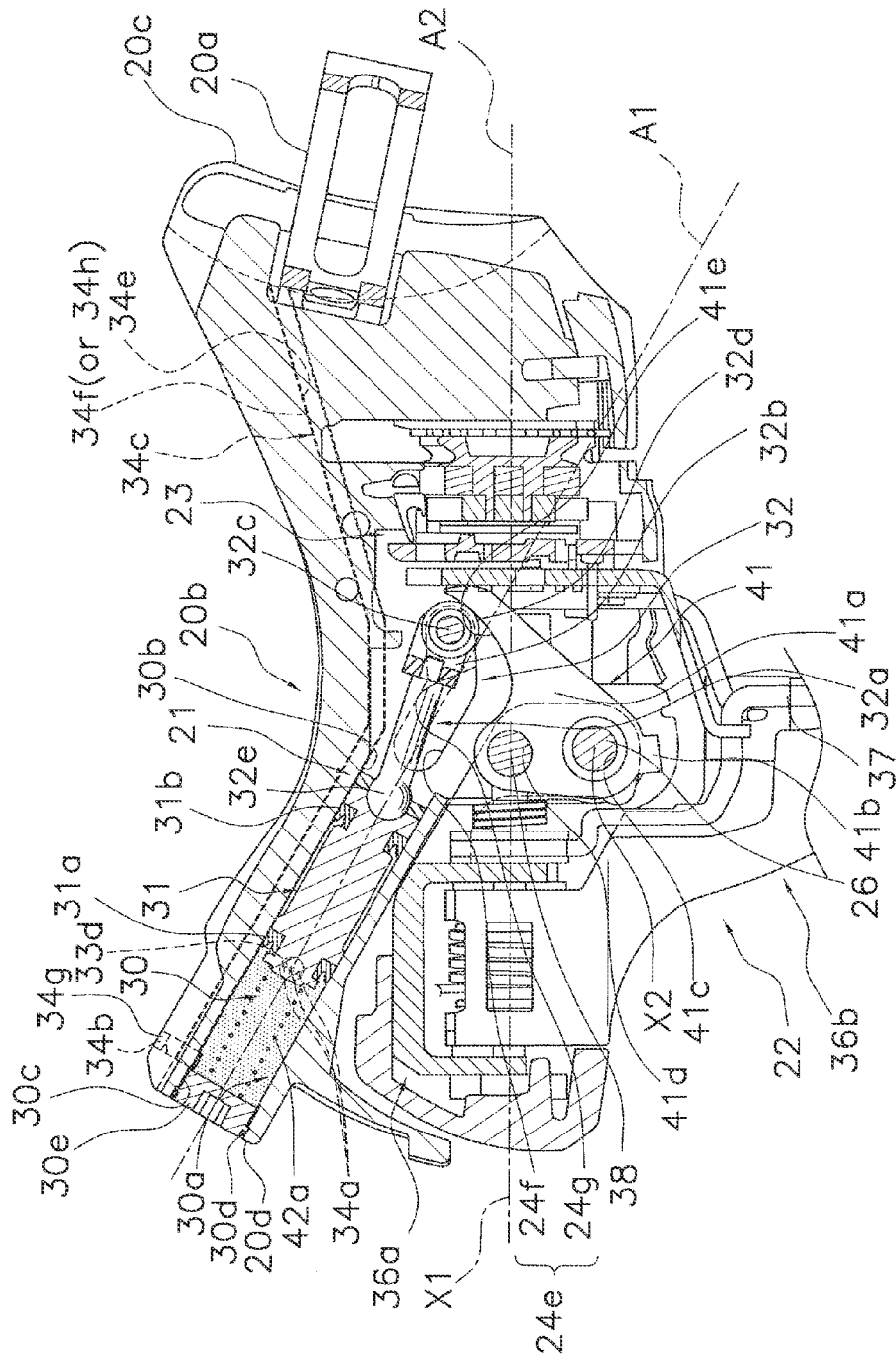


FIG. 5

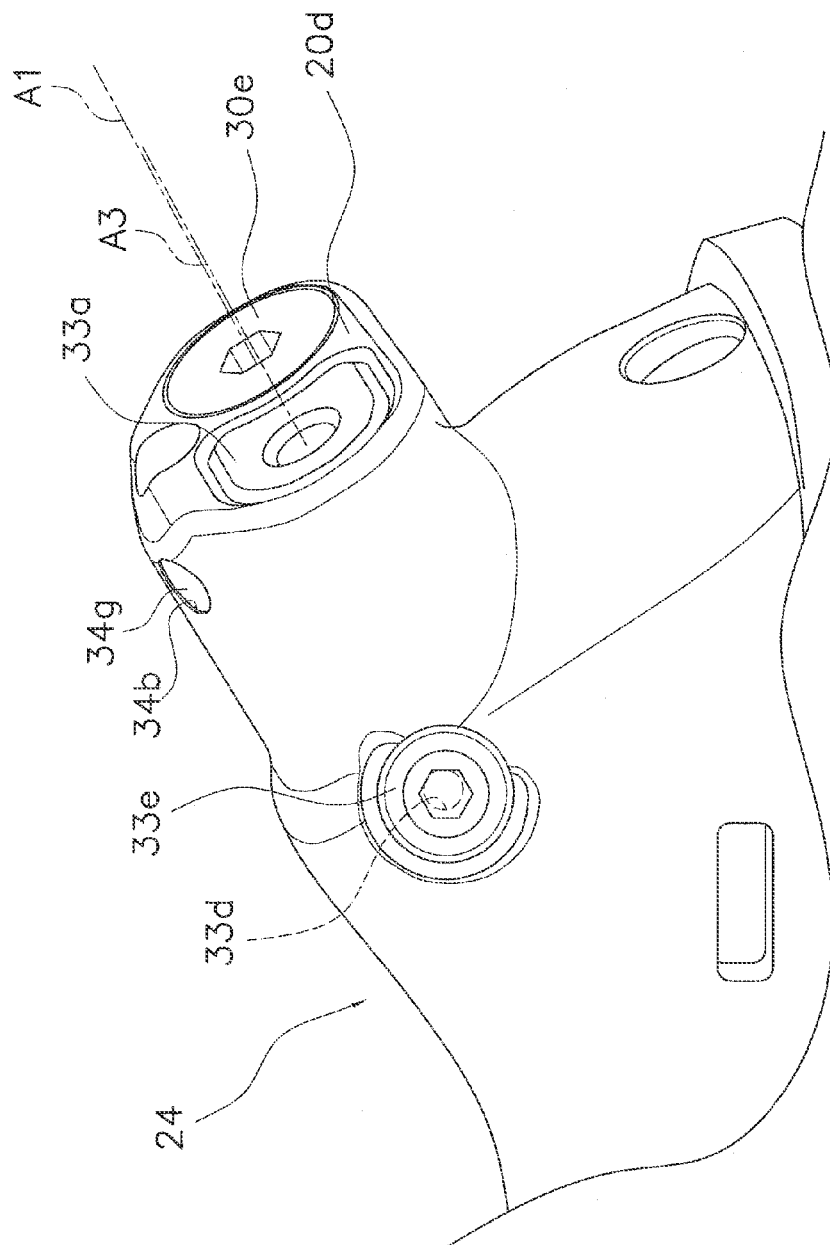


FIG. 6



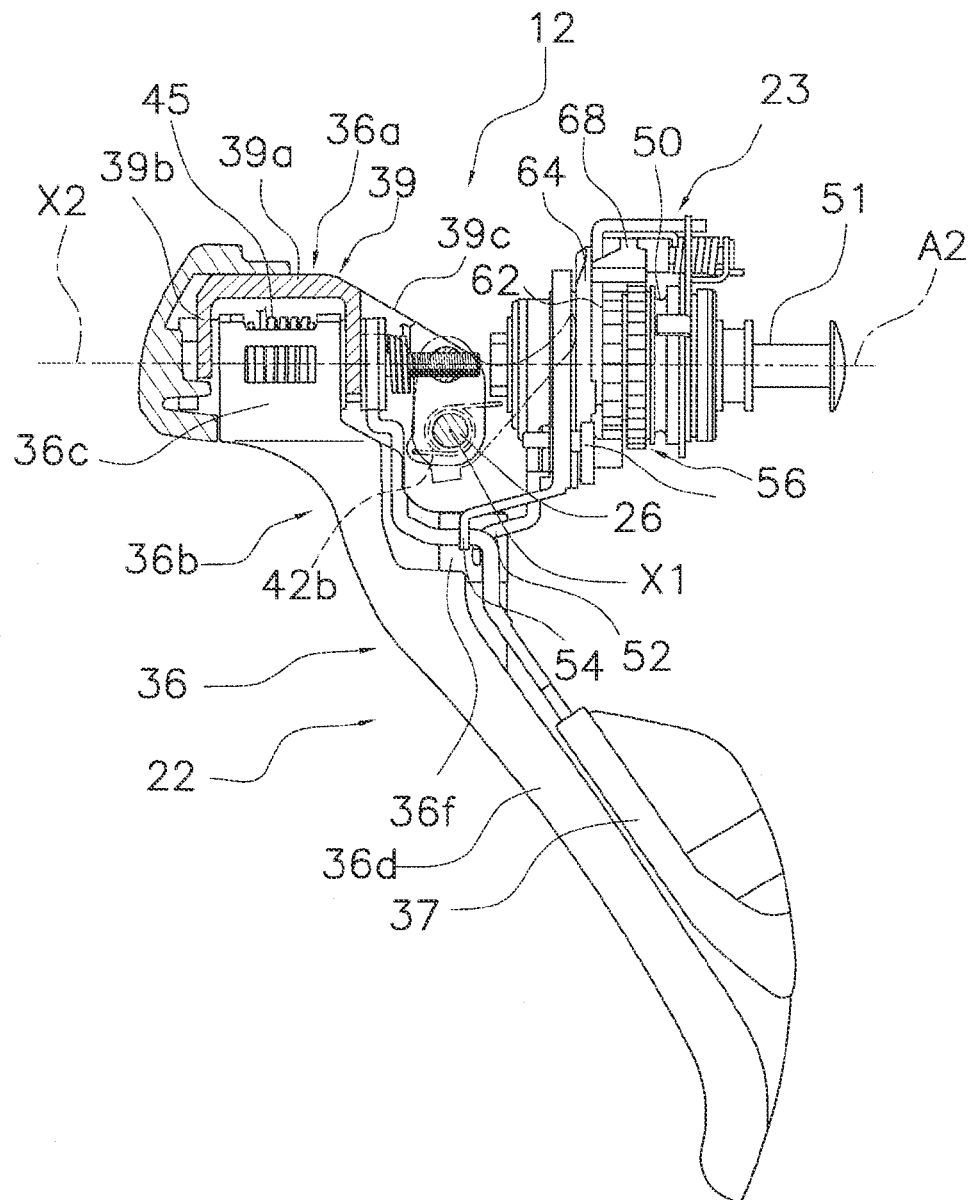


FIG. 7

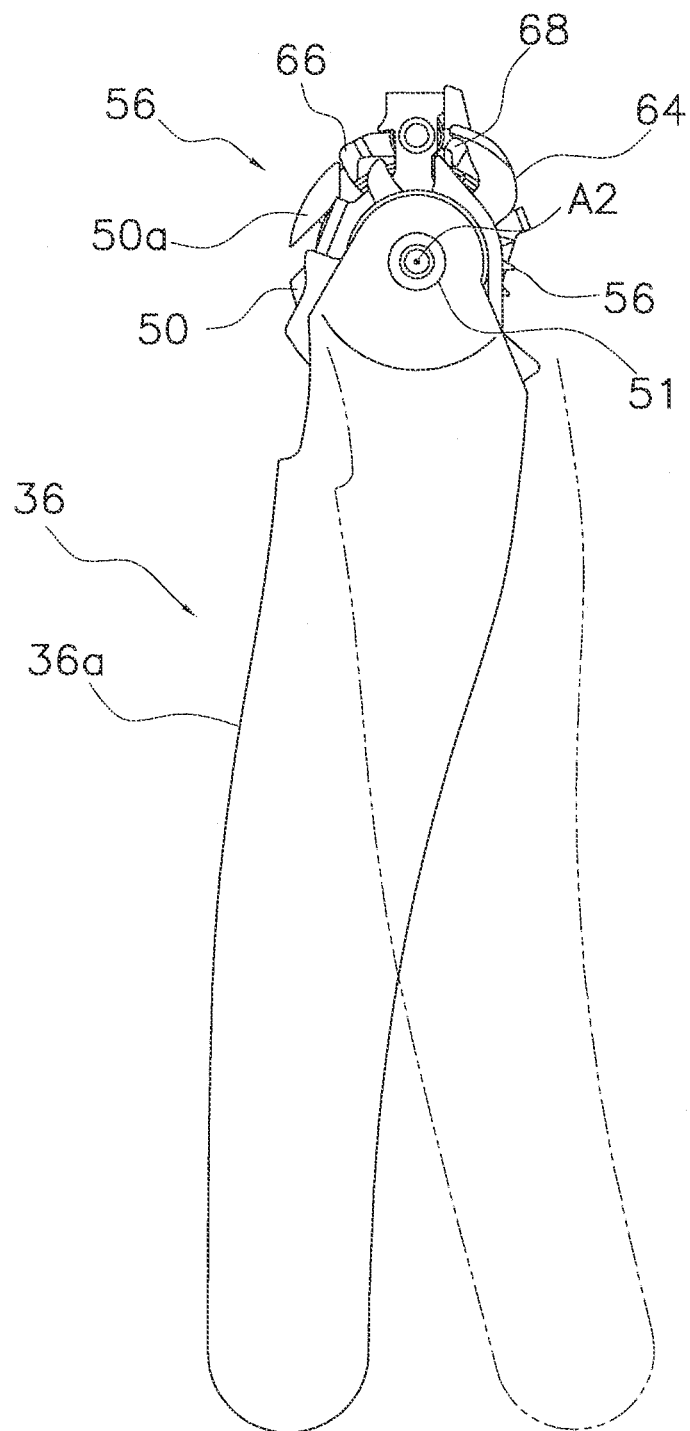


FIG. 8

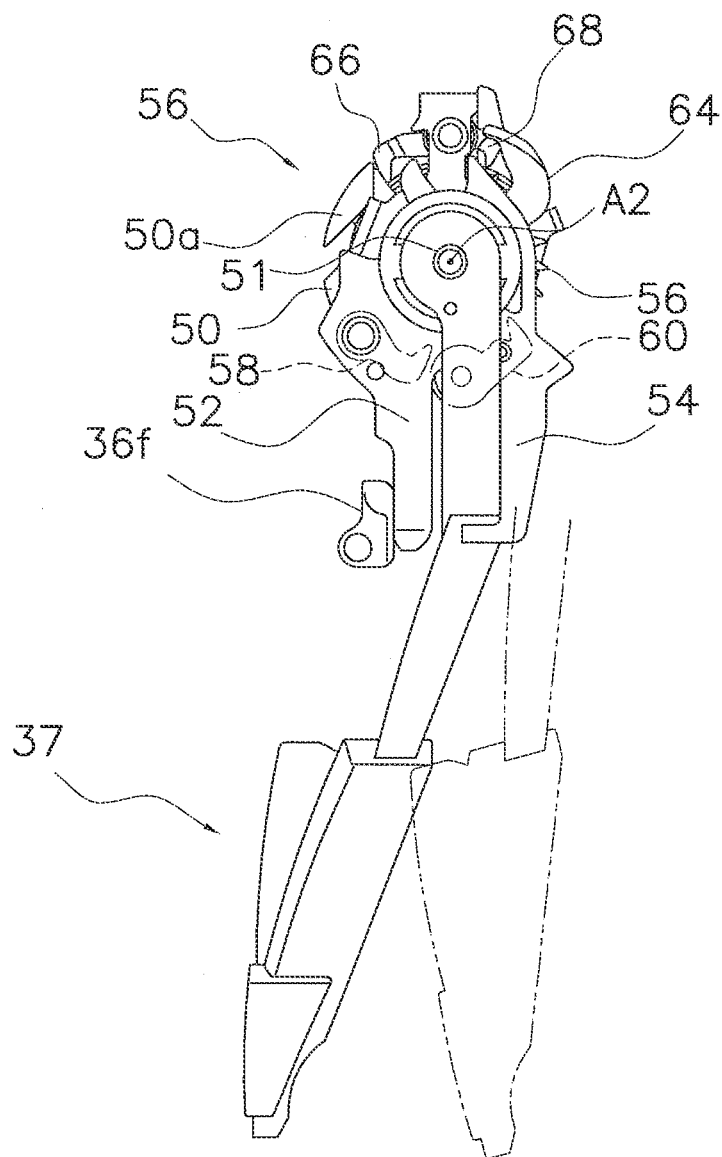


FIG. 9

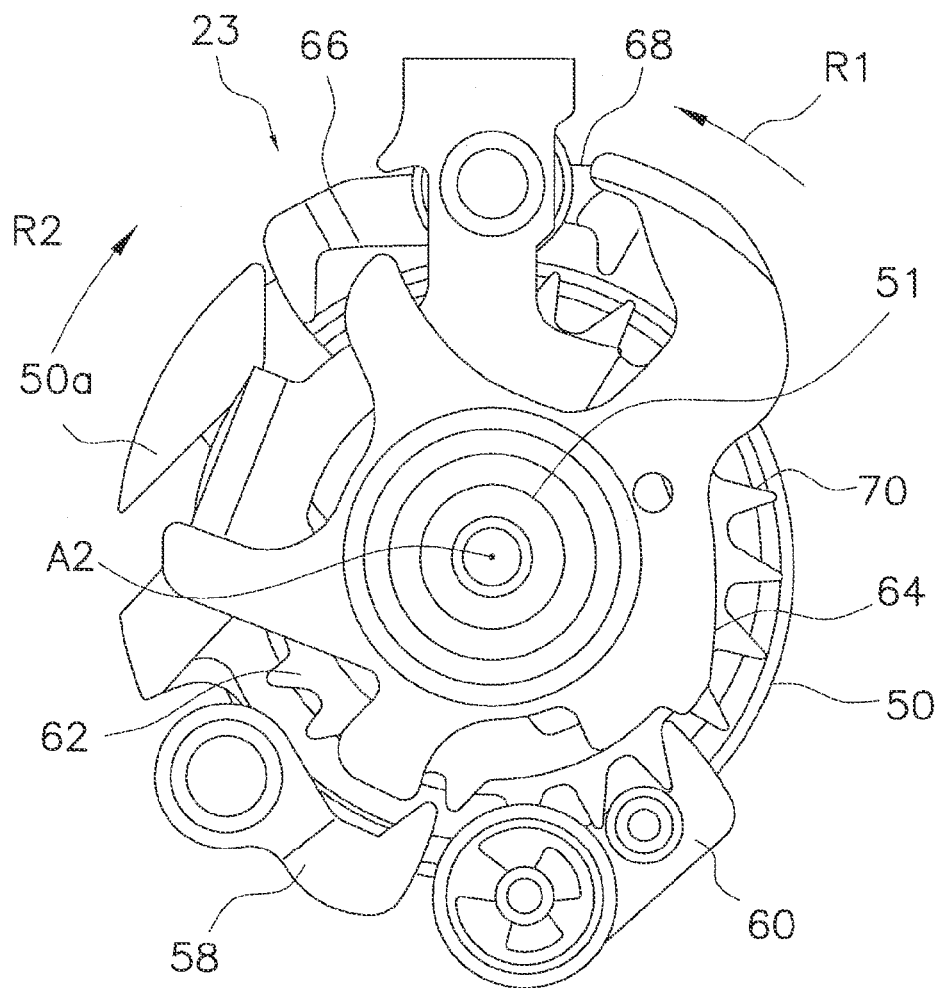


FIG. 10

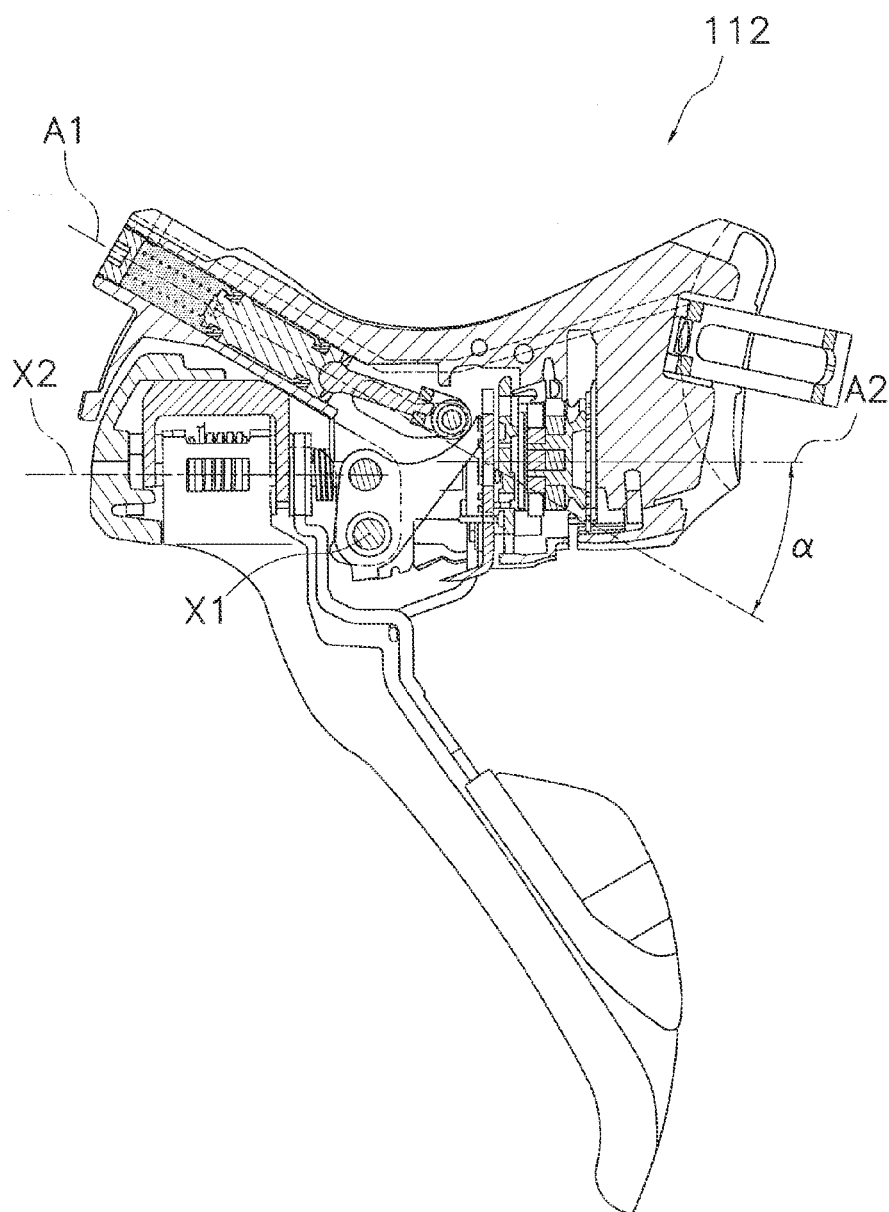


FIG. 11

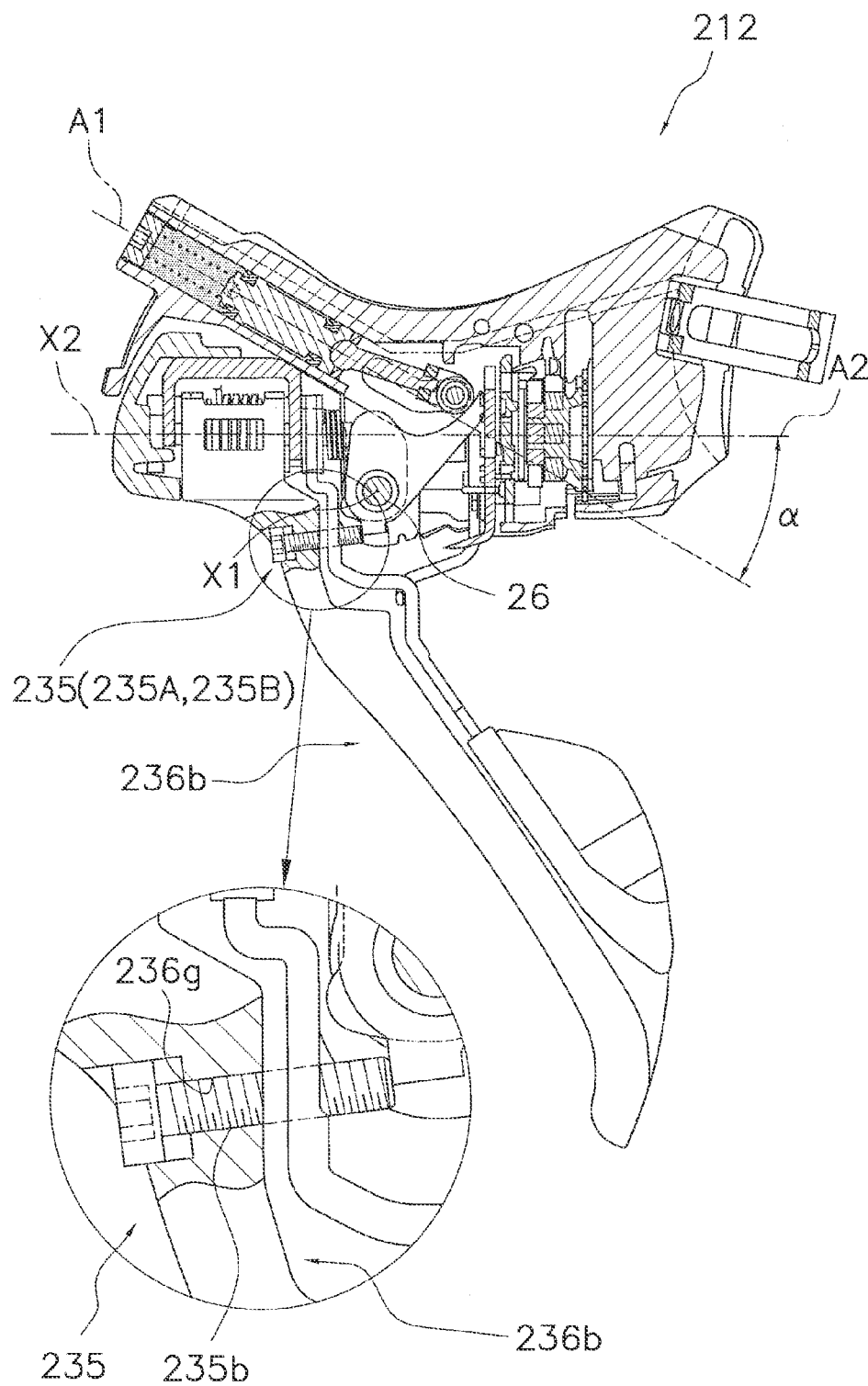


FIG. 12

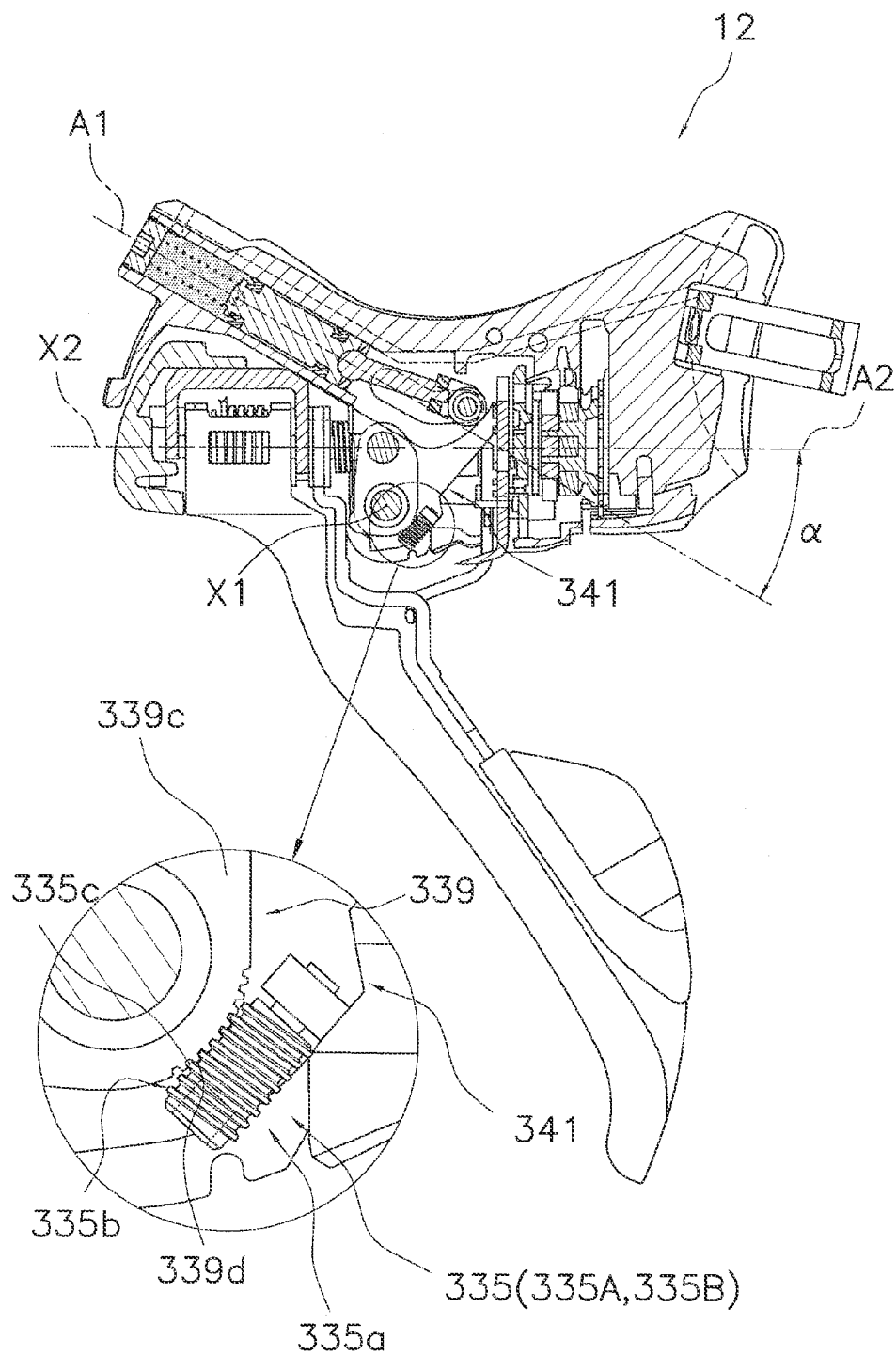


FIG. 13

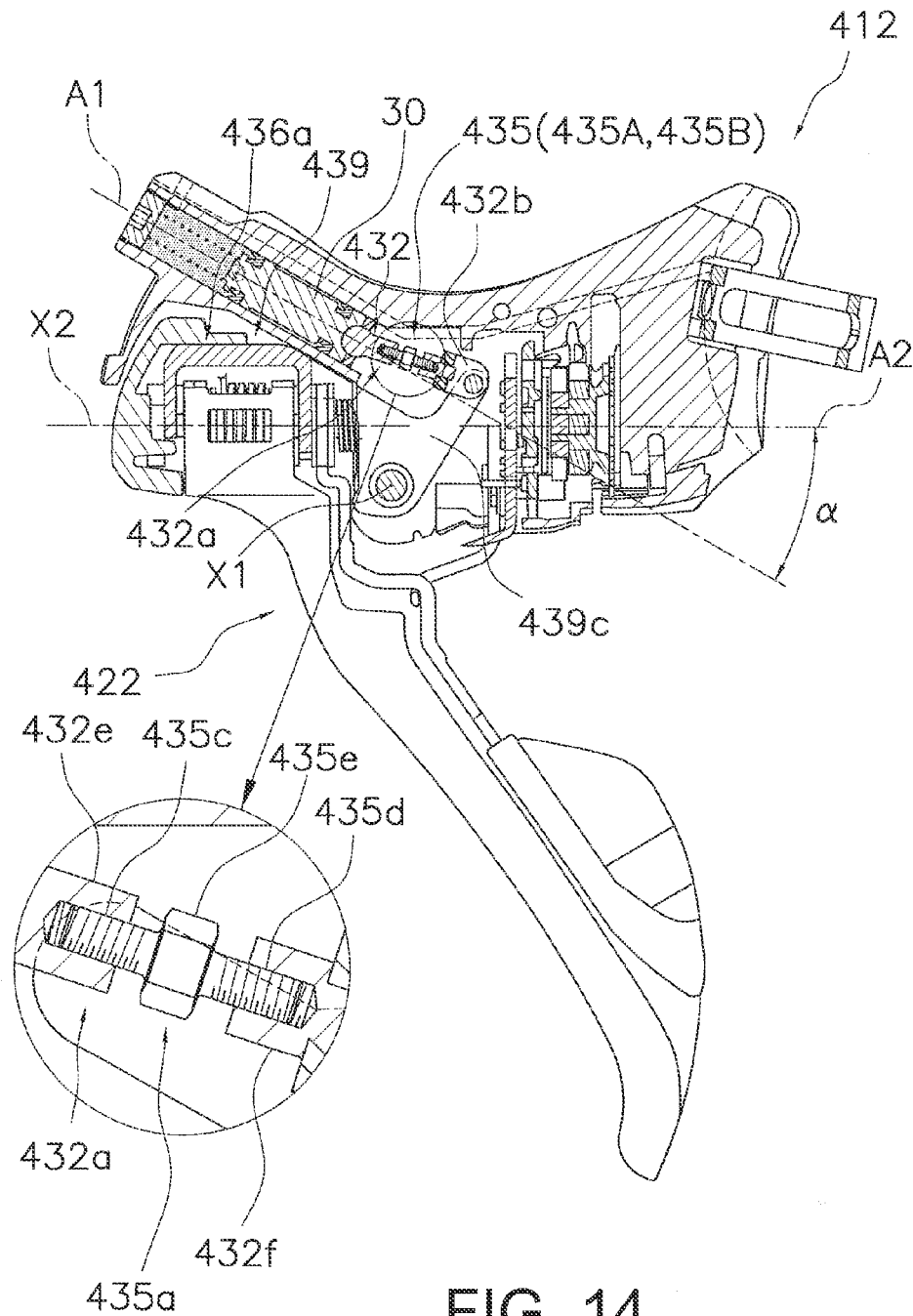


FIG. 14



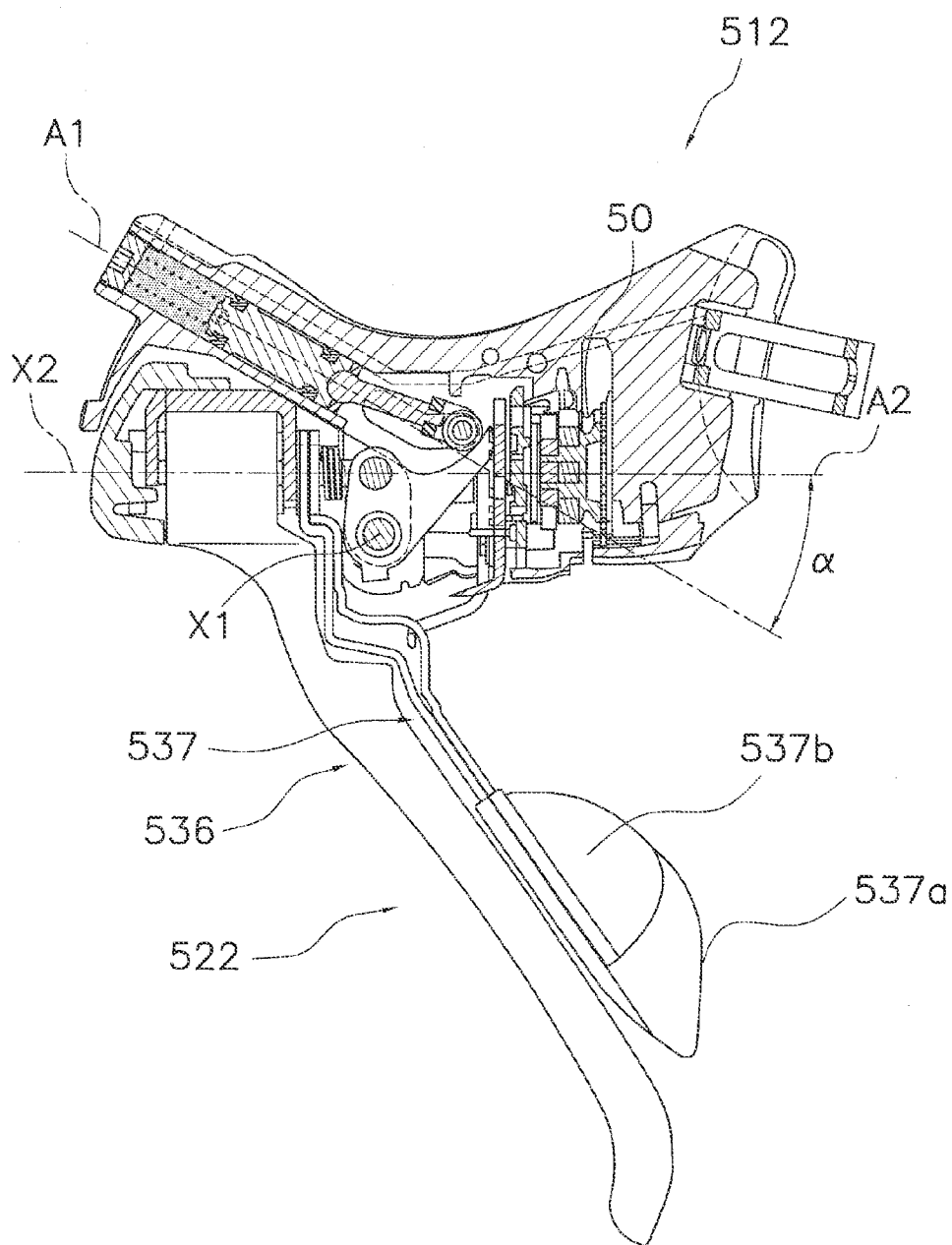


FIG. 15

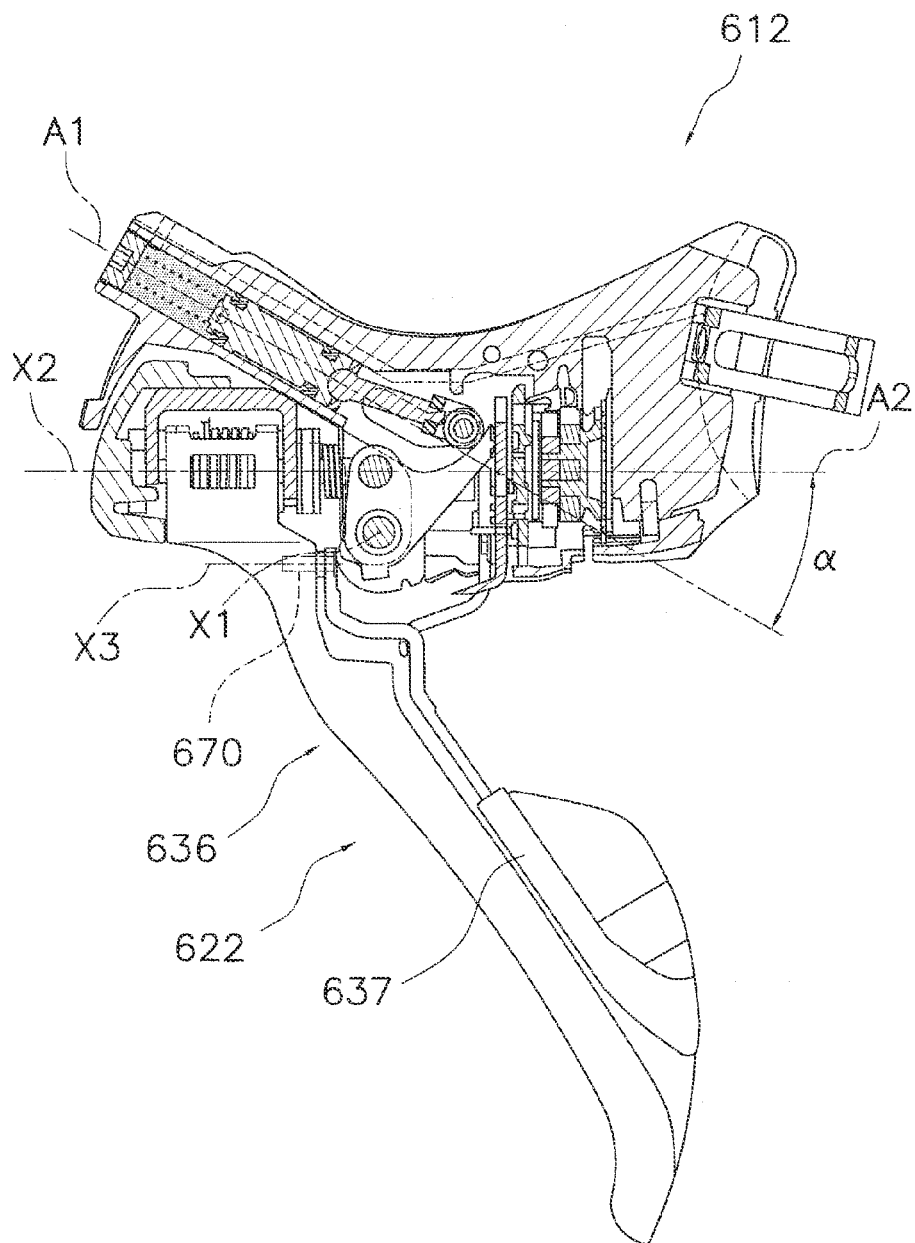


FIG. 16

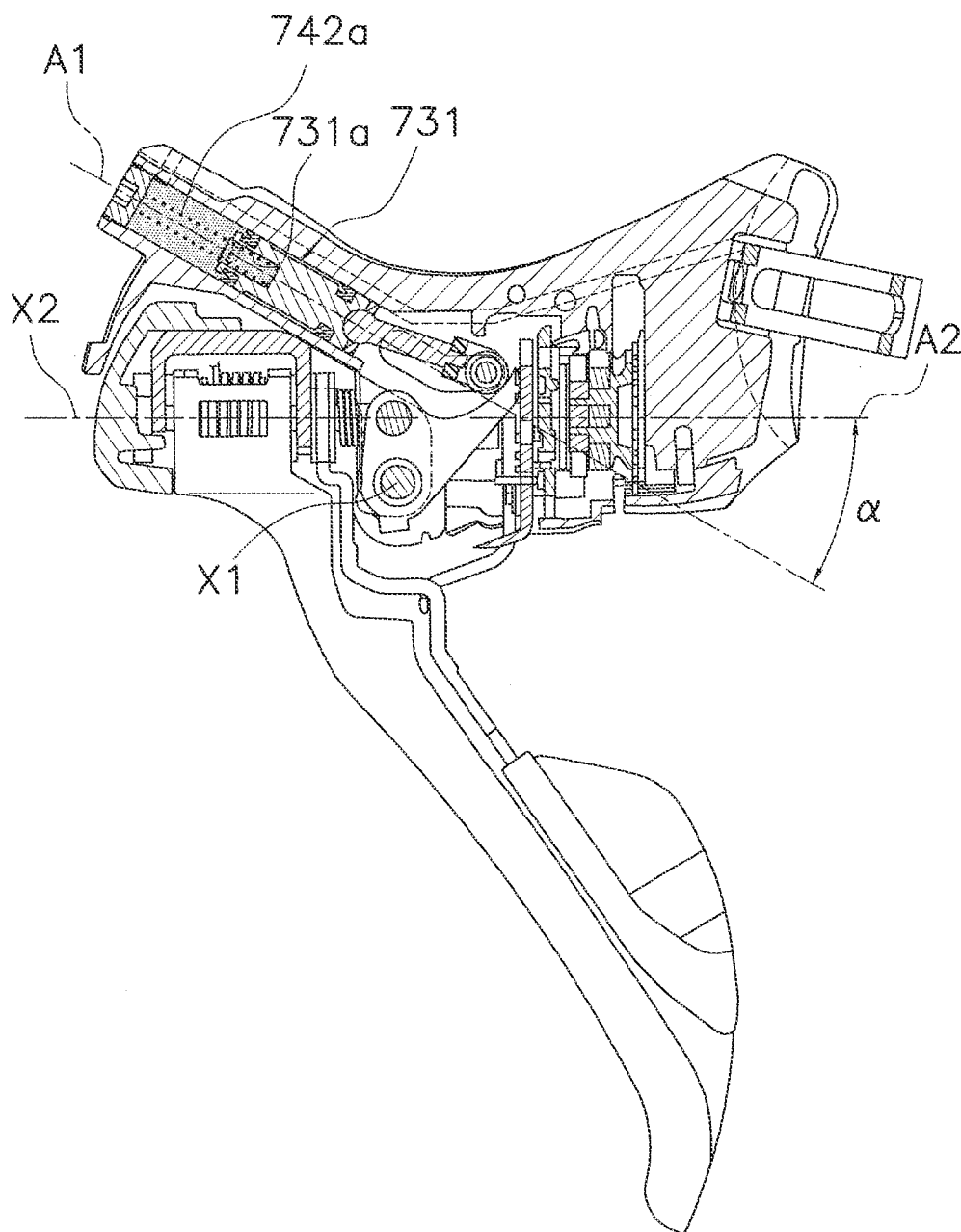


FIG. 17

1

**BICYCLE CONTROL DEVICE****CROSS-REFERENCE TO RELATED APPLICATIONS**

This application claims priority under 35 U.S.C. §119 to Japanese Patent Application No. 2012-007805, filed Dec. 26, 2012. The entire disclosure of Japanese Patent Application No. 2012-007805 is hereby incorporated herein by reference.

**BACKGROUND****1. Field of the Invention**

This invention generally relates to a bicycle control device. More specifically, the present invention relates to a bicycle control device which can be mounted on the handlebar of a bicycle and which can control a braking device and a shifting device.

**2. Background Information**

Bicycle control devices are conventionally known, which can be mounted on a handlebar of a bicycle for controlling both a braking device and a shifting device (for example, see European Patent Application Publication No. 2308750). Typically, a conventional bicycle control device is provided with a housing member having an attachment part capable of being attached to a handlebar and a grip part capable of being gripped by a rider by hand, a control lever member having a first operating lever and a second operating lever, and a shift-operating mechanism provided on a first end side (the handlebar side) of the grip part. In the bicycle control device disclosed in European Patent Application Publication No. 2308750, the shift-operating mechanism is provided within the grip part, allowing the control lever member to be made lighter and more compact.

Bicycle control devices are also known in the prior art that perform a braking operation on a bicycle using hydraulic pressure (for example, see Chinese Patent Publication No. M386235). The control device is typically provided on the handlebar. The control device often includes a hydraulic fluid pressure generator being disposed along the direction in which the handlebar extends, and a cylinder and reservoir being disposed in line vertically.

**SUMMARY**

Generally, it is possible that the hydraulic fluid pressure generator of Chinese Patent Publication No. M386235 could be applied to the bicycle control device of European Patent Application Publication No. 2308750, which is capable of controlling a braking device and a shifting device. However, in the bicycle control device of Chinese Patent Publication No. M386235, the shift-operating mechanism is provided within the grip part of the housing member. Therefore, if the hydraulic fluid pressure generator of European Patent Application Publication No. 2308750 were provided in the grip part along the handlebar, the grip part would increase in size, causing the grip part to be harder for the rider to grip. If the grip part is harder to grip, the control lever member will be harder to operate. Accordingly, in order to avoid increasing the size of the grip part, the hydraulic fluid pressure generator could be provided along the direction in which the grip part extends. However, if the hydraulic fluid pressure generator is disposed along the direction in which the grip part extends, the direction in which the control lever member extends and the direction in which the hydraulic fluid pressure generator extends will be substantially perpendicu-

2

lar, making it difficult to effectively transmit the operating force of the control lever member to the cylinder.

The present invention addresses the problem of facilitating operation of the control lever member and enabling effective transmission of the operating force of the control lever member to the hydraulic fluid pressure generator in a bicycle control device having a shift-operating mechanism in the grip part and being capable of performing a shifting operation and a braking operation.

In view of the state of the known technology and in accordance with a first aspect of the present disclosure, a bicycle control device is provided that is capable of being mounted on the handlebar of a bicycle and capable of controlling a braking device and a shifting device. The bicycle control device basically comprises a housing member, a control lever member, a shift-operating mechanism and a hydraulic fluid pressure generator. The housing member has an attachment part configured to be attached to a handlebar, and a grip part extending longitudinally between a first end of the grip part and a second end of the grip part. The attachment part is provided on the first end of the grip part. The control lever member pivots with respect to the housing member. The shift-operating mechanism is provided in the housing member. The shift-operating mechanism includes a cable take-up member rotatably mounted around a cable take-up axis. The cable take-up member has a control cable attachment part that is configured to be coupled to a shifting device by a control cable. The hydraulic fluid pressure generator has a cylinder and a piston movably disposed within the cylinder by movement of the control lever member to generate fluid pressure for controlling a braking device. The cylinder is disposed in the housing member at a position closer toward the second end of the grip part than is the shift-operating mechanism to the second end of the grip part. The cylinder defines a cylinder axis that forms an angle of greater than or equal to 20° and less than or equal to 50° with the cable take-up axis.

In the bicycle control device of the first aspect, the shifting device is operated via the control cable when the grip part of the housing member is gripped and the control lever member is operated, actuating the shift-operating mechanism. The braking device is controlled by hydraulic pressure generated by the motion of the piston of the hydraulic fluid pressure generator when the control lever member is operated. Here, disposing the cylinder closer to the second end side of the grip part than the shift-operating mechanism allows the grip part to be made thinner, allowing the lever to be operated more easily. Also, because the cylinder axis of the hydraulic fluid pressure generator is inclined 20°-50° relative to the cable take-up axis of the shift-operating mechanism, when the control lever member is operated from the grip part, the operating force of the control lever member can be transmitted more efficiently to the hydraulic fluid pressure generator. Since the second edge side of the grip part is brought forward and up, the grip part is easier to grasp when going up a hill.

In accordance with a second aspect, the bicycle control device according to the first aspect is configured so that the control lever member includes a first operating lever that pivots around a first axis relative to the housing member for operating the piston, and a second operating lever that pivots around a second axis for operating the cable take-up member of the shift-operating mechanism. The second axis is different from the first axis relative to the housing member. In this aspect, by separately providing a first operating lever for operating the braking device and a second operating lever for operating the shifting mechanism, it is possible to

3

prevent incorrect operation and, because the axes of rotation of the two operating levers are different, to even more effectively prevent incorrect operation

In accordance with a third aspect, the bicycle control device according to the second aspect is configured so that the cable take-up axis and the second axis are coaxial. In this aspect, since the cable take-up axis and the second axis are disposed on the same axis, the control lever member and the shift-operating mechanism can be disposed compactly.

In accordance with a fourth aspect, the bicycle control device according to the third aspect is configured so that the cable take-up axis and the second axis are non-coaxial axes. In this aspect, since the cable take-up axis and the second axis are disposed on different axes, the control lever member and the shift-operating mechanism may be disposed in any desired position, allowing the grip part to be reduced in size.

In accordance with a fifth aspect, the bicycle control device according to any of the first through fourth aspects is configured so that the cylinder has a cylindrical shape defining a cylinder axis. In this aspect, making the cylinder cylindrical increases the efficiency with which the generated hydraulic pressure is dispersed and transmitted, and makes it easier to preserve the seal between the cylinder and the piston.

In accordance with a sixth aspect, the bicycle control device according to any of the first through fifth aspects is configured so that the cylinder having an open end on a piston side and a closed end on a side opposite the open end. Also the open end is in a lower position than the closed end when the bicycle control device is in an installed position. In this aspect, by disposing the open end of the cylinder higher than the first axis of the control lever member, it is possible to increase the efficiency with which the piston is operated relative to the pivoting operation of the control lever member.

In accordance with a seventh aspect, the bicycle control device according to the sixth aspect is configured so that the closed end of the cylinder is sealed shut by a sealing member. In this aspect, machining or forming used to form the cylinder can be performed from the closed-end side, making the cylinder easier to form.

In accordance with an eighth aspect, the bicycle control device according to any of the first through seventh aspects is configured so that the angle formed between the cylinder center axis and the cable take-up axis is greater than or equal to 25° and less than or equal to 40°. In this aspect, the grip part can be formed in a shape approximating the cable-type grip of the prior art, preventing the rider from experiencing any unfamiliarity.

Also other objects, features, aspects and advantages of the disclosed bicycle control device will become apparent to those skilled in the art from the following detailed description, which, taken in conjunction with the annexed drawings, discloses one embodiment of the bicycle control device.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Referring now to the attached drawings which form a part of this original disclosure:

FIG. 1 is a perspective view of a bicycle control device mounted to a portion of a drop handlebar according to a first embodiment, a side elevational view of a front portion of a bicycle with a bicycle braking device controlled by the bicycle control device and a schematic view of a rear derailleur controlled by the bicycle control device;

4

FIG. 2 is a partial cross sectional view of the bicycle control device according to the first embodiment with the section taken along a longitudinal center of the reservoir part of the bicycle control device;

FIG. 3 is a cross sectional view of the bicycle control device according to the first embodiment with the section taken along a longitudinal center of the cylinder part of the bicycle control device having the cover thereof removed, and with selected part shown in elevation;

FIG. 4 is a cross sectional view, similar to FIG. 3, of the bicycle control device, when the bicycle control device is operated to perform a braking operation of the bicycle braking device;

FIG. 5 is a partial longitudinal cross sectional view of the bicycle control device according to the first embodiment with the section taken along a longitudinal center of the housing member of the bicycle braking device to illustrate an upper portion of the control lever member and the shift-operating mechanism;

FIG. 6 is a partial perspective view of an end part of the grip part of the housing member of the bicycle braking device according to the first embodiment;

FIG. 7 is a side elevational view of the control lever member and the shift-operating mechanism of the bicycle control device illustrated in FIG. 4, with a portion of the control lever member shown in cross section for purposes of illustration;

FIG. 8 is a front elevational view of the first operating lever of the bicycle control device for operating the bicycle braking device and the shift-operating mechanism with the first operating lever shown in full lines for illustrating the rest position and shown in broken lines for illustrating an operated position to operate the shift-operating mechanism;

FIG. 9 is a front elevational view of the second operating lever of the bicycle control device for operating the shift-operating mechanism with the first operating lever shown in full lines for illustrating the rest position and shown in broken lines for illustrating an operated position to operate the shift-operating mechanism;

FIG. 10 is a front elevational view of the shift-operating mechanism of the bicycle control device;

FIG. 11 is a cross sectional view of a bicycle control device according to a first modification of the bicycle control device illustrated in FIG. 3, with the section taken along a longitudinal center of the cylinder part of the bicycle control device, and with selected part shown in elevation;

FIG. 12 is a cross sectional view of a bicycle control device according to a second modification of the bicycle control device illustrated in FIG. 3, with the section taken along a longitudinal center of the cylinder part of the bicycle control device, and with selected part shown in elevation;

FIG. 13 is a cross sectional view of a bicycle control device according to a third modification of the bicycle control device illustrated in FIG. 3, with the section taken along a longitudinal center of the cylinder part of the bicycle control device, and with selected part shown in elevation;

FIG. 14 is a cross sectional view of a bicycle control device according to a fourth modification of the bicycle control device illustrated in FIG. 3, with the section taken along a longitudinal center of the cylinder part of the bicycle control device, and with selected part shown in elevation;

FIG. 15 is a cross sectional view of a bicycle control device according to a fifth modification of the bicycle control device illustrated in FIG. 3, with the section taken along a longitudinal center of the cylinder part of the bicycle control device, and with selected part shown in elevation;

5

FIG. 16 is a cross sectional view of a bicycle control device according to a sixth modification of the bicycle control device illustrated in FIG. 3, with the section taken along a longitudinal center of the cylinder part of the bicycle control device, and with selected part shown in elevation; and

FIG. 17 is a cross sectional view, similar to FIG. 3, of a bicycle control device according to another embodiment, with the section taken along a longitudinal center of the cylinder part of the bicycle control device, and with selected part shown in elevation.

#### DETAILED DESCRIPTION OF EMBODIMENTS

Selected embodiments will now be explained with reference to the drawings. It will be apparent to those skilled in the bicycle field from this disclosure that the following descriptions of the embodiments are provided for illustration only and not for the purpose of limiting the invention as defined by the appended claims and their equivalents.

Referring initially to FIG. 1, a perspective view of a bicycle control device 12 that is mounted to a portion of a drop handlebar 13 according to a first embodiment. Here, only the bicycle control device 12 on the right side of the drop handlebar 13 is shown in FIG. 1. However, it will be apparent that the left side of the drop handlebar 13 has a similar bicycle control device that includes the features of the bicycle control device 12 as discussed herein.

A shift cable 14 acting as a control cable connects the right bicycle control device 12 to a rear derailleur 15. The shift cable 14 is a Bowden cable having an inner cable and an outer casing. A hydraulic fluid pressure hose 16 connects the right bicycle control device 12 to a braking device 18 for braking a front wheel 17. The braking device 18 is a hydraulic fluid pressure disc brake device which is actuated by hydraulic fluid pressure. The braking device 18 includes a brake disc 18a and a caliper 18b. The brake disc 18a is fixedly attached in an integrally manner to a hub 17a of the front wheel 17 so as to rotate with the front wheel 17. The caliper 18b is fixed to a front fork 19 of the bicycle. The caliper 18b brakes or slows the rotation of the front wheel 17 by squeezing the brake disc 18a upon being actuated by the right bicycle control device 12. The left control device (not shown) is coupled to a front derailleur via a shift cable (both not shown), and is also coupled to a braking device of a rear wheel (not shown), for example, via a hydraulic fluid pressure hose. The front derailleur and the rear derailleur 15 are examples of shifting devices. The right-side control device 12 and the left-side braking device (not shown) are mirror images of one another, and except for having different numbers of shift positions, the structure and operation of the bicycle control devices are substantially identical. Thus, only the right-side control device 12 will be described and illustrated in detail herein. In the following description, the bicycle control device is referred to simply as the control device.

Because a majority of the components of the bicycle are conventionally known in the relevant art, details relating to the components of the bicycle are not described or illustrated herein, except for components pertinent to the control device 12 of the present invention. Furthermore, various components of a conventional bicycle not illustrated or described herein, including braking devices, shifting devices, sprockets, and the like, can also be used together with the control device 12 according to the present invention.

As shown in FIGS. 2 and 3, the control device 12 has a housing member 20, a hydraulic fluid pressure generator 21,

6

a control lever member 22, a shift-operating mechanism 23 (see FIG. 3) and an adjustment mechanism 35. The housing member 20 basically has an attachment part 20a and a grip part 20b. The attachment part 20a is capable of being attached to a curved part 13a that formed in the end of the drop handlebar 13 of the bicycle. The grip part 20b is provided with the attachment part 20a, and is configured to be gripped by a rider during riding. The attachment part 20a is a conventionally-known band-shaped member, and the control device 12 can be fixed to the drop handlebar 13 by fastening the attachment part 20a by a screw.

The grip part 20b extends longitudinally between a first end 20c and a second end 20d. The grip part 20b has a main grip body 24 and an elastic cover member 25. The main grip body 24 is made of a synthetic resin such as a polyamide resin or a metal such as aluminum. The elastic cover member 25 has an elastic piece that covers the outside surface of the main grip body 24.

The top or upper surface of the main grip body 24 has a downward-curving shaped surface to facilitate gripping of the grip part 20b by hand. As shown in FIGS. 2 and 3, the main grip body 24 has a first housing section 24a (see FIG. 2) provided on the first end 20c side, a second housing section 24b provided on the second end 20d side, and a first bracket 24c provided between the first housing section 24a and the second housing section 24b. The first housing section 24a houses the shift-operating mechanism 23. The second housing section 24b houses a second bracket 39, described below, of the control lever member 22. The hydraulic fluid pressure generator 21 is disposed above the second housing section 24b and aligned with and spaced apart from the shift-operating mechanism 23 in the longitudinal direction. A pair of left and right first brackets 24c is provided that supports both ends of a lever shaft 26 to which the control lever member 22 so as to pivot around a first axis X1. The lever shaft 26 is disposed in a left-to-right direction substantially perpendicular to the direction of travel of the bicycle, and has the first axis X1 as its axis. A curved recession 24d that curves so as to following the curved part 13a of the drop handlebar 13 is formed on the first end 20c side of the main grip body 24.

As shown in FIGS. 2, 3, and 5, the hydraulic fluid pressure generator 21 is provided in order to provide hydraulic pressure to the braking device 18 and cause the braking device 18 to brake. The hydraulic fluid pressure generator 21 includes a cylinder 30, a piston 31, a rod 32 and a reservoir 33 (see FIG. 2). The cylinder 30 is formed in the main grip body 24. The piston 31 moves linearly within the cylinder 30 (i.e., reciprocates linearly within the cylinder 30). The rod 32 is mechanically coupled to the piston 31. The reservoir 33 fluidly coupled to the cylinder 30. The hydraulic fluid pressure generator 21 generates hydraulic pressure through the operation of the piston 31 in an insertion direction of the cylinder 30. The hydraulic fluid pressure generator 21 further includes a first hydraulic fluid channel 34a (see FIG. 5), an outlet port 34b (see FIG. 5), a second hydraulic fluid channel 34c (see FIG. 5), a connection part 34d and a piston-position-adjusting mechanism 35A (see FIG. 2).

Preferably, the cylinder 30 is formed integrally with the main grip body 24. The cylinder 30 is formed, for example, by cutting or die molding from the second end 20d side of the main grip body 24. The cylinder 30 is formed in a cylindrical shape having a cylinder axis A1. The cylinder 30 has a movement space 30a through which the piston 31 moves. The movement space 30a has an open end 30b on a side near the cylinder 30, and a closed end 30c on the second end 20d side opposite the open end 30b. The closed end 30c

is sealed by a first seal member **30d**. The first seal member **30d** has a seal member **30e** for sealing the gap with the cylinder **30** formed thereby, and is screwed into the closed end **30c**. The closed end **30c** is disposed at a higher position than (i.e., above) the open end **30b**. Thus, the cylinder axis A1 is disposed so as to incline upwards towards the front. An angle of intersection  $\alpha$  connecting the cylinder axis A1 and a cable take-up axis A2 described hereafter, the angle being seen from the side in FIG. 3, is greater than or equal to  $20^\circ$  and less than or equal to  $50^\circ$ . Setting the angle of intersection  $\alpha$  in this range allows increases in the size of the grip part **20b** to be minimized even if the cylinder **30** is disposed inclined toward the cable take-up axis A2. In the present embodiment, the angle of intersection  $\alpha$  is approximately  $30^\circ$ . The cylinder axis A1 is located in front of the cable take-up axis A2 in a left-to-right direction perpendicular with the plane of the drawing in FIG. 3 (i.e., to the left of the cable take-up axis A2), and does not intersect therewith in a plane view.

The piston **31** is a substantially cylindrical member. The piston **31** has a first seal member **31a** and a second seal member **31b** installed on the outer circumferential surface of the piston **31** on both ends thereof. The first seal member **31a** and the second seal member **31b** have, for example, an O-ring shape. The first seal member **31a** and the second seal member **31b** are provided in order to seal the gap between the inner circumferential surface of the movement space **30a** of the cylinder **30** and the outer circumferential surface of the piston **31**. It is also acceptable for there to be only one seal member. The piston **31** moves within the movement space **30a** between a first position, shown in FIG. 3, at the distal end of the cylinder **30** and a second position, shown in FIG. 4, located deeper within than the first position in response to a braking operation performed by the brake lever member **22**. The piston **31** is biased towards the first position by a first return spring **42a**.

The rod part **32** withdraws in the cylinder **30** in response to an operation of the brake lever member **22** in the braking direction. The rod part **32** is coupled to the piston **31** so as to freely pivot around an axis substantially parallel to the first axis X1. The rod part **32** has a rod body **32a**, a dual-peaked clevis pin **32b** mounted on a tip of the rod body **32a**, a rotational shaft **32c** inserted in the clevis pin **32b**, and a pair of left and right rollers **32d** attached to the rotational shaft **32c** so as to be freely rotatable. The left and right rollers **32d** are disposed apart from each other by a distance of 1.5 to 2.5 times the diameter of the roller part **32d**. The rod body **32a** is a rod-shaped member. The rod body **32a** has a cylinder insertion end **32e** engaging with the piston **31**. The cylinder insertion end **32e** is a partial sphere having a greater diameter than the rest of the rod body **32a**. Thus, in the present embodiment, the rod part **32** freely pivots with respect to the cylinder **30** on an axis parallel to the second axis X2. The two ends of the rotational shaft **32c** engage with a pair of guide grooves **24e** provided in the main grip body **24**. The guide grooves **24e** have a first part **24f** disposed along the cylinder axis A1 and a second part **24g** bending upward from the first part **24f**. The roller part **32d** is depressed by a cam member **41**, described hereafter. The cam member **41** is provided on the brake lever member **22**. Thus, when the roller part **32d** is depressed by the cam member **41**, the rotational shaft **32c** at the distal end of the rod part **32** gradually approaches cylinder axis A1. The angle formed by the rod part **32** and the cylinder axis A1 thereby gradually decreases, facilitating the movement of the piston **31** within the cylinder **30**.

As shown in FIG. 2, the reservoir **33** is capable of storing hydraulic fluid for generating hydraulic pressure. The reservoir **33** is provided so that the necessary amount of hydraulic fluid can be injected from the reservoir **33** even if the friction material (for example, a brake pad) of the braking device **18** becomes worn, which as a result may require large amounts of hydraulic fluid. Also, the reservoir **33** prevents inconsistencies in the pressure being applied to the braking device **18** due to swelling and contraction caused by changes in the temperature of the hydraulic fluid. The reservoir **33** is formed in a cylindrical shape having a reservoir axis A3. The reservoir **33** is provided in the grip part **20b** spaced apart from and aligned with the cylinder **30** in a left-to-right direction intersecting the longitudinal direction. The reservoir axis A3 is essentially parallel with the cylinder axis A1, and at essentially the same height. Thus, the reservoir **33** is formed to the interior of the cylinder **30** at the same inclination as the cylinder **30** in a right-to-left direction perpendicular with the surface of the drawing in FIG. 2. The reservoir **33** inclines upward and forward on the second end side of the main grip body **24**. The reservoir **33** has a first end-side first closed end **33b** and a second end-side second closed end **33c**. At least one of the first closed end **33b** or the second closed end **33c** is sealed by a second seal member **33a** which is detachably installed in the reservoir **33**. In the present embodiment, the second end-side second closed end **33c** is sealed by the second seal member **33a**. The second seal member **33a** is fixed in the reservoir via suitable means, such as bonding, pressure injection, screws, or the like. As shown in FIG. 6, the reservoir **33** has a hydraulic fluid injection hole **33d** opening on a side surface capable of being opposed to the first hydraulic fluid channel **34a** on the second end **20d** of the main grip body **24**. The hydraulic fluid injection hole **33d** is sealed by a hydraulic fluid injection cap **33e** detachably installed on the end of the hydraulic fluid injection hole **33d**.

As shown in FIG. 5, the first hydraulic fluid channel **34a** is provided in order to fluidly connect the cylinder **30** and the reservoir **33**. The first hydraulic fluid channel **34a** is disposed closer to the second end **20d** than is the first seal member **31a** to the second end **20d** when the piston **31** is disposed in the first position. The first hydraulic fluid channel **34a** is disposed closer to the rod part **32** than is the first seal member **31a** to the rod part **32** when the piston **31** is disposed in the second position. In the present embodiment, the first hydraulic fluid channel **34a** is oppositely disposed with respect to the hydraulic fluid injection hole **33d**. The first hydraulic fluid channel **34a** is constituted by a plurality of holes (for example, three holes) of a smaller diameter than the hydraulic fluid injection hole **33d** so as to be formable via the hydraulic fluid injection hole **33d**.

The outlet port **34b** serves to convey hydraulic pressure generated in the cylinder **30** to the exterior. When the piston **31** is disposed in the second position, the outlet port **34b** is disposed closer to the second end **20d** than the first seal member **31a**. The outlet port **34b** is formed penetrating the inner circumferential surface of the cylinder **30** and the side surface of the main grip body **24**. The side surface-penetrating part of the outlet port **34b** is sealed by a plug **34g**.

The second hydraulic fluid channel **34c** is coupled to the outlet port **34b**. The second hydraulic fluid channel **34c** communicates with the outlet port **34b** and extends bending toward the first end **20c**. The second hydraulic fluid channel **34c** is constituted by a hydraulic pressure tube **34f** that is disposed within a tube hole **34e**. The tube hole **34e** extends from the first end **20c** and the second end **20d**. The upper part of the main grip body **24** curves in a downward

recession. Thus, the second hydraulic fluid channel **34c** is arranged to define a substantially flattened V shape.

The connection part **34d** is connected to the second hydraulic fluid channel **34c**. The connection part **34d** communicates with the outlet port **34b** via the second hydraulic fluid channel **34c**. The connection part **34d** is connectable with the exterior hydraulic pressure hose **16** (see FIG. 1), which is capable of being coupled to the braking device **18**. As seen in FIG. 2, the connection part **34d** is disposed adjacent to side of the second hydraulic fluid channel **34c** that is located at the first end **20c**, i.e., the connection part **34d** is disposed adjacent to the first end **20c** of the housing member **20**.

In the present embodiment, the adjustment mechanism **35** has a piston-position-adjusting mechanism **35A** capable of adjusting the initial position of the piston with respect to the cylinder, and a control lever position adjustment mechanism **35B** capable of adjusting the initial position of the control lever with respect to the housing.

The piston-position-adjusting mechanism **35A** has a function of adjusting the first position of the piston **31** with respect to the cylinder **30** (an example of the initial position of the piston **31**). The piston-position-adjusting mechanism **35A** also has a function of actuating the piston **31** while coupled to the first operating lever **36** and a cam member **41** described hereafter. The piston-position-adjusting mechanism **35A** has an adjustment member **35a** for coupling a first operating lever **36**, described hereafter, of the control lever member **22** and the cam member **41**, also described hereafter. The adjustment member **35a** is an example of a first adjustment member. The adjustment member **35a** has an adjustment bolt **35b** penetrating a support shaft **40**, described hereafter, of the first operating lever **36**. Here, the adjustment bolt **35b** is an example of a first adjustment bolt.

A proximal head of the adjustment bolt **35b** catches on a through-hole **40a** of the support shaft **40**. A distal end of the adjustment bolt **35b** is screwed into a coupler shaft **38** provided on the cam member **41**, described hereafter, of the control lever member **22**. The initial position of the cam member **41** with respect to the first axis X1 can thus be adjusted, allowing the first position of the piston **31** to be adjusted. The second bracket **39** and the cam member **41** are coupled by the adjustment bolt **35b**, and the cam member **41** rotates in response to the pivoting of the first operating lever **36** around the first axis. Thus, the adjustment bolt **35b** has a function of adjusting the first position of the piston **31** and a function of coupling the first control lever member **22** to the cam member **41**.

The control lever position adjustment mechanism **35B** has a basic configuration similar to that of the piston-position-adjusting mechanism **35A**. The control lever position adjustment mechanism **35B** has a function of adjusting the first position of the first control lever member **22** with respect to the housing member **20** (an example of the initial position of the control lever member **22**). The control lever position adjustment mechanism **35B** has a function of actuating the piston **31** while coupled to the first operating lever **36**. The control lever position adjustment mechanism **35B** has a cam member **41** described hereafter. The piston-position-adjusting mechanism **35A** has an adjustment member **35a** for coupling a first operating lever **36**, described hereafter, of the control lever member **22** to the cam member **41**, also described hereafter. Here, the adjustment member **35a** is an example of a third adjustment member, and the adjustment bolt **35b** is an example of a third adjustment bolt. The adjustment member **35a** has an adjustment bolt **35b** penetrating a support shaft **40**, described hereafter, of the first

operating lever **36**. A proximal head of the adjustment bolt **35b** catches on a through-hole **40a** of the support shaft **40**. A distal end of the adjustment bolt **35b** is screwed into a coupler shaft **38** provided on the cam member **41**, described hereafter, of the control lever member **22**. It is thus possible to adjust the initial position of the control lever member **22** with respect to the first axis X1, as well as the first position of the control lever member **22**, i.e., the control lever member **22**. The second bracket **39** and the cam member **41** are coupled by the adjustment bolt **35b**. The cam member **41** rotates in response to the pivoting of the first operating lever **36** around the first axis X1. Thus, the adjustment bolt **35b** has a function of adjusting the first position of the first operating lever **36** and of coupling the first control lever member **22** and the cam member **41**.

Moreover, the adjustment mechanism **35** has a configuration similar to that the piston-position-adjusting mechanism **35A** and the control lever position adjustment mechanism **35B**. Thus, by coupling the second bracket **39**, the cam member **41** and the first operating lever **36**, the adjustment bolt **35b** has a function of adjusting the first position of the piston **31**, a function of adjusting the first position of the first operating lever **36** and a function of coupling the first control lever member **22** and the cam member **41**. Here, the adjustment member **35a** is an example of a fourth adjustment member, and the adjustment bolt **35b** is an example of a fifth adjustment bolt.

As shown in FIG. 2 and FIG. 7, the control lever member **22** includes the first operating lever **36**, the second operating lever **37** and the cam member **41**. The first operating lever **36** has a support member **36a** and a lever **36b** coupled to the support member **36a** so as to pivot around a second axis X2. The support member **36a** is coupled to the lever shaft **26** disposed on the housing member **20** so as to pivot around the first axis X1. The support member **36a** pivots around the first axis X1 from a first initial position shown in FIG. 2 to a pivoting position shown in FIG. 4. As shown in FIG. 7, the support member **36a** is biased towards the first initial position by a second return spring **42b** in the form of a coil spring. The second return spring **42b** is coiled around the lever shaft **26**. One end of the second return spring **42b** engages with the first bracket **24c** of the main grip body **24**, and another end engages with one of a pair of side plates **39c** of the support member **36a**, described hereafter.

As shown in FIG. 2, the support member **36a** has a second bracket **39** and a flanged hollow support shaft **40**. The second bracket **39** is formed by folding a sheet of metal front to back and left to right. The flanged hollow support shaft **40** is supported by the second bracket **39**. The second bracket **39** has a substantially rectangle base **39a**, a pair of front and back support plates **39b** and a pair of left and right side plates **39c**. The front and back support plates **39b** are formed by folding the front and back ends of the base **39a** downwards in parallel. The left and right side plates **39c** are formed by folding the left and right ends of the base **39a** downwards in parallel. The two ends of the support shaft **40** are supported by the support plates **39b**. The side plates **39c** extend backwards from the base **39a** and are supported by the lever shaft **26** so as to freely pivot around the first axis X1. The support shaft **40** is disposed along a direction not parallel with the first axis X1 (for example, a counter direction), i.e., along a second axis X2 substantially parallel with the direction of travel of the bicycle. The support shaft **40** is disposed above the lever shaft **26**. The support shaft **40** is mounted to the support plates **39b** of the support member **36a** by a nut **43** that screws onto an end of the support shaft



11

40. As described above, the adjustment bolt 35b is disposed penetrating the support shaft 40.

As shown in FIGS. 2 and 7, the lever 36b is coupled, along with the support member 36a, to the lever shaft 26 so as to freely pivot around the first axis X1. Also the lever 36b is coupled, along with the support member 36a, to the support shaft 40 so as to pivot around the second axis X2. The lever 36b is provided in order to perform braking operations and shifting operations in one direction of the rear derailleur 15. The lever 36b is controllably coupled to the shift-operating mechanism 23 so as to pivot around the second axis X2, thereby operating a cable take-up member 50, described hereafter, of the shift-operating mechanism 23 and taking up, i.e., pulling the shift cable 14, so as to upshift (or downshift) the rear derailleur 15. In addition, the pivoting of the lever 36b around the first axis X1 generates hydraulic pressure, thereby causing the braking device 18 to apply a braking force.

As shown in FIG. 2, the lever 36b has an insertion end part 36c, a shift operation part 36d and a free end part 36e. The lever 36b has a contact part 36f provided between the insertion end part 36c and the shift operation part 36d. The contact part 36f is capable of contacting the second operating lever 37 when the first operating lever 36 is operated from a second initial position to a first shift position. The second operating lever 37 can thus be pivoted together with the first operating lever 36. As shown in FIG. 8, the lever 36b moves around the second axis X2 between the second initial position, indicated by solid lines, and the first shift position, indicated by double dotted dashed lines. The insertion end part 36c is rotatably coupled to the support shaft 40. The shift operation part 36d extends downward from an end part of the housing member 20. The lever 36b is an example of a take-up lever. The lever 36b is biased towards the second initial position by a third return spring 45 coiled around the support shaft 40. One end of the third return spring 45 engages with the insertion end part 36c, and another end engages with a pair of bases 39a of the support member 36a.

In the present embodiment, the second operating lever 37 is coupled to an end of the support shaft 40 so as to freely pivot around the second axis X2, and is provided in order to perform shifting operations in the other direction of the rear derailleur 15. The second operating lever 37 is controllably coupled to the shift-operating mechanism 23 so as to operate the cable take-up member 50 and unwind, i.e., release the shift cable 14, thereby downshifting or upshifting the rear derailleur 15.

As shown in FIG. 9, the second operating lever 37 moves around the second axis X2 between a third initial position, indicated by solid lines, and a second shift position, indicated by double dotted dashed lines. The second operating lever 37 is rotatably attached to an end of the support shaft 40 so as to freely rotate around the second axis X2. As described above, the second operating lever 37 is controllably coupled to the shift-operating mechanism 23 so as to release the shift cable 14. The second operating lever 37 is an example of a release operating lever. The second operating lever 37 is biased towards the third initial position by a fourth return spring 46 (see FIG. 2) disposed between the support shaft 40 and the cam member 41. One end of the fourth return spring 46 engages with the insertion end of the second operating lever 37, and another end engages with the main grip body 24.

In the present embodiment, the shift-operating mechanism 23 is operated essentially by rotating the first operating lever 36 around the second axis X2 of the support shaft 40,

12

or by rotating the second operating lever 37 around the second axis X2 of the support shaft 40.

As shown in FIG. 5, the cam member 41 is provided so as to pivot around the first axis X1 and actuate the rod part 32 of the hydraulic fluid pressure generator 21 in response to the pivoting of the first operating lever 36 around the first axis X1. The cam member 41 has a pair of left and right cam plates 41a, and a coupling part 41b. The coupling part 41b is integrally formed with the pair of cam plates 41a for coupling the cam plates 41a. The cam plates 41a are disposed spaced apart from each other in the left-to-right direction with the same distance therebetween as between the pair of rollers 32d. The cam plates 41a has a through-hole 41c through which the lever shaft 26 can penetrate, a coupling hole 41d, and a cam surface 41e contacted by the rollers 32d. The through-hole 41c is formed on the lower part of the cam member 41. The coupling hole 41d is formed above the through-hole 41c. The coupling hole 41d supports a coupler shaft 38 for coupling to the first operating lever 36 via the piston-position-adjusting mechanism 35A. The coupling hole 41d is formed in a slightly elliptical shape so that the coupler shaft 38 is capable of movement in a direction connecting the coupling hole 41d and the through-hole 41c when the cam member 41 pivots. In the embodiment, the cam surface 41e has a curved recession formed therein so that, when the cam member 41 pivots, the degree of movement of the piston 31 in response to the rotation of the cam member 41 varies. Specifically, so that the degree of movement increases during an initial rotation period, and decreases after rotation has progressed. This allows for braking to take effect within a short period of time, and for the easy adjustment of braking force once braking has taken effect.

The cam member 41 is coupled to the lever shaft 26 penetrating the through-hole 41c so as to pivot around the first axis X1. A screw hole 38a into which the adjustment bolt 35b is screwed is formed in the coupler shaft 38 in a central part of the axial direction. The cam member 41 is biased in the clockwise direction in FIG. 5 by the second return spring 42b (see FIG. 7) that is provided on the lever shaft 26. The cam member is also biased in the clockwise direction in FIG. 5 by the first return spring 42a.

The shift-operating mechanism 23 will be briefly described with references to FIGS. 7-10. However, the shift-operating mechanism 23 is not limited to the structure described herein. A shift-operating mechanism of a different configuration can be used for the aforementioned control lever member 22 having the first operating lever 36 and the second operating lever 37. The shift-operating mechanism 23 is attached to a first end 29c side of the main grip body 24 of the housing member 20. The shift-operating mechanism 23 has a cable take-up member 50, a first input member 52, a second input member 54, and a positioning mechanism 56. The center of a cable take-up shaft 51 extending in the longitudinal direction of the grip part 20b is defined as the cable take-up axis A2. In the present embodiment, the cable take-up axis A2 is coaxial with the second axis X2.

An inner cable of the shift cable 14 is coiled around the cable take-up member 50. The cable take-up member 50 is attached to the cable take-up shaft 51 so as to freely rotate around the cable take-up axis A2. The cable take-up member 50 is biased in a cable unwinding direction by a return spring not shown in the drawings. Specifically, the return spring applies a biasing force to the cable take-up member 50 so as to rotate in the cable unwinding direction. The cable take-up member 50 has a substantially cylindrical shape having a cable attachment part 50a capable of attaching to a nipple

13

(not shown) mounted on an end of the inner cable of the shift cable 14. When the first operating lever 36 is operated from the second initial position towards the first shift position, the cable take-up member 50 rotates around the cable take-up axis A2 in a first rotational direction R1 (see FIG. 10) and takes up the inner cable. When the second operating lever 37 is operated from the third initial position towards the second shift position, the cable take-up member 50 rotates around the cable take-up axis A2 in a second rotational direction R2 (see FIG. 10) and reels out the inner cable.

The first input member 52 and the second input member 54 are independently coupled to the first operating lever 36 and the second operating lever 37 so as to allow a shifting operation to be performed. The first input member 52 pivots around the cable take-up axis A2 in response to the pivoting of the first operating lever 36 around the second axis X2. As shown in FIG. 7, an end of the first input member 52 is capable of contacting the contact part 36f of the lever 36b. Thus, when the first operating lever 36 is pivoted around the second axis X2 from the second initial position to the first shift position, the first input member 52 pivots around the cable take-up axis A2.

The second input member 54 pivots around the cable take-up axis A2 in response to the pivoting of the second operating lever 37 around the second axis X2. An end of the second input member 54 is capable of contacting an intermediate part of the second operating lever 37. Thus, when the second operating lever 37 is pivoted around the second axis X2 from the third initial position to the second shift position, the second input member 54 pivots around the cable take-up axis A2.

The positioning mechanism 56 is a mechanism for determining the rotational position of the cable take-up member 50 according to the gear shift lever. The positioning mechanism 56 has a take-up pawl 58, a release pawl 60, a take-up plate 62, a release plate 62, a positioning pawl 66, a detent pawl 68, and a positioning plate 70. The take-up pawl 58 is pivotally provided on the first input member 52. The take-up pawl 58 pivots together with the first input member 52 when the first operating lever 36 is operated from the second initial position towards the first shift position. The take-up pawl 58 thus urges the cable take-up member against the biasing force of the return spring and rotates the cable take-up member 50 in the first rotational direction R1.

The release pawl 60 is pivotally provided on the second input member 54. The release pawl 60 pivots together with the second input member 54 when the second operating lever 37 is operated from the third initial position towards the second shift position. The release pawl 60 is thereby detached from the cable take-up member 50, and the cable take-up member 50 is rotated in the second rotational direction R2 by the biasing force of the return spring.

The take-up plate 62 and the positioning plate 70 are attached to the cable take-up member 50, and rotate integrally with the cable take-up member 50. The take-up plate 62 has a plurality of take-up cogs. The take-up cogs selectively engage with the take-up pawl 58. The cable take-up member 50 thus rotates in the first rotational direction R1.

The positioning plate 70 has a plurality of positioning cogs. The positioning cogs selectively engage with the positioning pawl 66. The cable take-up member 50 is thereby kept at a predetermined shift position after either a take-up operation by the first operating lever 36 or a release operation by the second operating lever 37.

The release plate 62 is rotated by the release pawl 60 in the first rotational direction R1 so that the positioning pawl 66 and the detent pawl 68 selectively engage and disengage

14

with the release plate 62 from the positioning plate 70 so as to rotate the cable take-up member 50 in the second rotational direction R2.

In the embodiment shown in the drawings, a rider can rotate the first operating lever 36 from a first initial position to a braking position while grasping the drop handlebar 13 or the curved part of the grip part 20b. The first operating lever 36 rotates around the first axis X1. The rotation of the first operating lever 36 causes the piston 31 of the hydraulic fluid pressure generator 21 to be depressed, generating hydraulic pressure within the cylinder 30, and the hydraulic pressure activates the braking device 18, braking the bicycle.

The first operating lever 36 is capable of rotating around the second axis X2 and pivoting sideways from the second initial position to a shift position in order, for example, to downshift the rear derailleur 15 into a lower gear. When released, the first operating lever 36 is returned to the second initial position by the biasing force of the third return spring 45. The second operating lever 37 is capable of pivoting sideways from a resting position in order, for example, to upshift to a higher gear, and, when released, is returned to the third initial position by the biasing force of the fourth return spring 46.

When the first operating lever 36 is pivoted in order to shift gears, the second operating lever 37 pivots along with the first operating lever 36 instead of moving in opposition to the first operating lever 36. The first operating lever 36 is thus capable of pivoting without being impeded by the second operating lever 37.

While grasping the lowest position of the curved part of the drop handlebar 13, a rider can, for example, extend the middle finger or ring finger of the hand grasping the curved part, place the finger on the first operating lever 36, and pull the first operating lever 36 to a braking position, i.e., towards the curved part 13a. This operation of the lever causes the shift-operating mechanism 23 to rotate around the first axis X1 with the support member 36a. This rotational movement of the first operating lever 36 generates hydraulic pressure, braking the bicycle.

#### First Modification

In the following description, only those features differing from the embodiment described above are described and numbered in the drawings, and description of the configuration and operation of other features similar to those of the embodiment described above, as well as numbering thereof in the drawings, will be omitted.

In the embodiment described above, the second axis X2 and the cable take-up axis A2 were coaxial, but the present invention is not limited to such a configuration. As shown in FIG. 11, the second axis X2 and the cable take-up axis A2 can be on different axes in a control device 112. In FIG. 11, the cable take-up axis A2 of a shift-operating mechanism 123 is disposed below the second axis X2 of a control lever member 122. The cable take-up axis A2 and the second axis X2 may also be disposed so as to intersect.

#### Second Modification

In the embodiment described above, the adjustment bolt 35b of the adjustment mechanism 35 (i.e., the piston-position-adjusting mechanism 35A and the control lever position adjusting mechanism 35B) is disposed penetrating the support shaft 40 along the second axis X2, but the present invention is not limited to such a configuration. In a control device 212 according to a second modification, as

15

shown in FIG. 12, an adjustment bolt 235b (an example of a second adjustment bolt, a fourth adjustment bolt, or a sixth adjustment bolt) serving as an adjustment member 235a (an example of a second adjustment member or a fourth adjustment member) of an adjustment mechanism 235 (constituted by a piston-position-adjusting mechanism 235A and a control lever position adjustment mechanism 235B) is disposed near a lever shaft 26 having a first axis X1. The adjustment bolt 235b is screwed into a screw hole 236g formed in the lever 36b, and an end thereof contacts a coupling part 241b of a cam member 241. The second initial position of a first operating lever 236 is thus altered and the position of a piston 31 moves into the cylinder 30. The cam member 241 is biased in the clockwise direction in FIG. 12 by a first return spring 42a disposed on the cylinder 30. Here, there is no need for an adjustment bolt penetrating the interior of the support shaft 40 and coupling the second bracket 39 and the cam member 241. The support member and the cam member may also be integrally formed. In such a case, there is also no need for an adjustment bolt penetrating the support member.

#### Third Modification

In a control device 312 according to a third modification, as shown in FIG. 13, an adjustment member 335a (an example of a first adjustment member) of an adjustment mechanism 335 (constituted by a piston-position-adjusting mechanism 335A and a control lever position adjustment mechanism 335B) is constituted by a worm gear bolt 335b attached to a cam member 341. The worm gear bolt 335b has worm gear cogs 335c formed on an outer circumferential surface. Worm wheel cogs 339d meshing with the worm gear cogs 335c are formed on one of a pair of side plates 339c of a first bracket 339 of a support member 336a. In this case, the adjustment bolt of the embodiment described above is used as a coupling bolt for coupling a second bracket 339 of the control lever member 22 and a cam member 341.

#### Fourth Modification

In a control device 412 according to a fourth modification, as shown in FIG. 14, an adjustment mechanism 435 (constituted by a piston-position-adjusting mechanism 435A or a control lever position adjustment mechanism 435B) has an adjustment member 435a, capable of adjusting the relative positions of a control lever member 422 and a piston, and adapted for coupling the piston 31 and the control lever member 422. The adjustment member 435a is an example of a second adjustment member. Specifically, the piston 31 is coupled to a second bracket 439 of a support member 436a of a control lever member 422 via a rod part 432. Therefore, a cam member is not provided.

The rod part 432 does not have a roller, and side plates 439c of a second bracket 439 are pivotably coupled to a clevis pin 432b. A rod body 432a, has a first rod body 432e coupled to the cylinder 30, and a second rod body 432f disposed spaced apart from the first rod body 432e. The clevis pin 432b is disposed on the second rod body 432f. The adjustment member 435a has an adjustment screw 435b that screws into the first rod body 432e and the second rod body 432f and adjusts the length of the rod part 432. The rotation of the first rod body 432e around an axis is restricted.

The adjustment screw 435b has a first male screw 435c, a second male screw 435d and a rotatably operated noncircular grip part 435e. The first male screw 435c screws into

16

the first rod body 432e. The second male screw 435d screws into the second rod body 432f. The rotatably operated noncircular grip part 435e is disposed between the first male screw 435c and the second male screw 435d. The rotatably operated noncircular grip part 435e can have, for example, a hexagonal shape. The first male screw 435c is, for example, a right-handed screw, and the second male screw 435d is, for example, a left-handed screw.

In the adjustment mechanism 435 (the piston-position-adjusting mechanism 435A or the control lever position adjustment mechanism 435B) having the configuration described above, the first rod body 432e and the second rod body 432f move toward each other, shortening the rod part 432, when the grip part 435e is turned by hand or using a tool in a first direction (for example, in a clockwise direction towards the piston). The first position of the piston 31 is thereby moved backwards (to the right in FIG. 14). When the grip part 435e is turned by hand or using a tool in a second direction, the first rod body 432e and the second rod body 432f move away from each other, lengthening the rod part 432. The first position of the piston 31 is thereby moved forwards (to the left in FIG. 14). This configuration also allows the first position of the piston 31 to be adjusted.

In the fourth modification, the piston-position-adjusting mechanism 435A or control lever position adjustment mechanism 435B is realized according to the magnitude of the biasing force of the first return spring 42a biasing the piston towards the first position and the second return spring 42b returning a control lever member 422 to the first initial position. Typically, the piston-position-adjusting mechanism 435A will be realized due to the larger magnitude of the biasing force of the second return spring 42b. If the biasing force of the second return spring 42b is less than the biasing force of the first return spring 42a, the control lever position adjustment mechanism 435B will be realized.

#### Fifth Modification

In a control device 512, as shown in FIG. 15, a second operating lever 537 of a control lever member 522 has a take-up operating lever 537a and a release operating lever 537b. A first operating lever 536 pivots only around a first axis X1, and does not pivot around a second axis X2. The pivoting of the take-up operating lever 537a around the second axis X2 pivots the first input member 52, actuating the cable take-up member 50 in a take-up direction. The pivoting of the release operating lever 537b around the second axis X2 pivots the second input member 54, actuating the cable take-up member 50 in a release direction opposite the take-up direction.

#### Sixth Modification

In a control device 612, as shown in FIG. 16, a second operating lever 637 of a control lever member 622 pivots not around the second axis X2, but around a third axis X3 of a support shaft 670 disposed on a first operating lever 636 further towards a distal end than the second axis X2. The support shaft 670 is mounted to a first operating lever 636.

#### Other Embodiments

Embodiments of the present invention have been described above, but the present invention is not limited to these embodiments; various modifications are possible to the extent that they remain within the spirit of the invention. In particular, the various embodiments and modifications

17

described in the present specification can be combined according to discretion as necessary.

(a) In the first and second embodiments, a disk-brake device is given as an example of a braking device capable of being operated using hydraulic pressure, but the braking devices controlled by the present invention are not limited to a disk-brake device. The present invention is applicable to a control device for controlling any bicycle braking device capable of being operated using hydraulic pressure. For example, the present invention is also applicable to a bicycle control device for controlling a braking device such as a caliper brake or a drum brake operated using hydraulic pressure.

(b) In the embodiment described above, a reservoir for storing hydraulic fluid for generating hydraulic pressure is provided, allowing hydraulic fluid to be injected into the cylinder when the level of hydraulic fluid in the cylinder decreases, and suppressing changes in braking characteristics regardless of changes in hydraulic fluid temperature, but the present invention can also be applied to a bicycle control device not having a reservoir.

(c) In the hydraulic fluid pressure generator **21** of the embodiment described above, hydraulic pressure is generated by pressing the piston **31**, i.e., moving the piston **31** into the cylinder **30**, but the present invention is not limited to such a configuration. For example, hydraulic pressure may be generated by pulling on the piston, i.e., drawing the piston out of the cylinder. In such a case, the pulling force acts only upon the rod part serving as a coupling part for the piston and the first operating lever. This prevents buckling from occurring in the rod part, allows the rigidity of the coupling part to be reduced, and decreases the weight of the rod part. However, in such a case, a force equivalent to the hydraulic pressure multiplied by the area of the rod subtracted from the area of the cylinder of the rod is generated, requiring a cylinder having a greater diameter than that of the embodiment described above.

(d) In the embodiment described above, an end of the first return spring **42a** contacts an end surface of the piston **31**, but, as shown in FIG. **17**, an end of a first return spring **742a** may be housed within a housing hole **731a** that is formed in a piston **731**. This enables a space for housing the spring when the piston **731** returns to the second position to be easily ensured. A heightened degree of freedom in designing the spring is thus obtained.

(e) In the embodiment described above, the control lever member **22** is constituted by a first operating lever **36** for performing braking operations and shifting operations, and a second operating lever **37** for performing shifting operations. However, it is also acceptable to adopt a configuration in which a braking operation is performed by pivoting one operating lever around the first axis, a first shifting operation (for example, a downshift operation) is performed by pivoting the lever in one direction around a second axis, and a second shifting operation (for example, an upshift operation) is performed by pivoting the lever in the other direction around the second axis.

(f) In the embodiment described above, a first return spring **42a** and a second return spring **42b** are provided on the first operating lever **36** and the hydraulic fluid pressure generator **21**, but it is also acceptable to provide only a first return spring **42a**. If a cam member and a roller are not provided and the second bracket is directly coupled to the rod part, it is acceptable to provide only one of the first return spring or the second return spring.

(g) In the embodiment described above, a hydraulic pressure tube **34f** is used as the second hydraulic fluid

18

channel **34c** in FIG. **5**, but an interior hydraulic pressure hose **34h** passing through the tube hole **34e** or between the cover member **25** and the main grip body **24** may also be used. It is also possible to form a hole in the grip part **20b** for creating a second hydraulic fluid channel. In such cases, the end of the hole must be sealed by a plug.

As used herein, the following directional terms “forward”, “rearward”, “front”, “rear”, “up”, “down”, “above”, “below”, “upward”, “downward”, “top”, “bottom”, “side”, “vertical”, “horizontal”, “perpendicular” and “transverse” as well as any other similar directional terms refer to those directions of a bicycle in an upright, riding position and equipped with the control device **12**. Accordingly, these directional terms, as utilized to describe the control device **12** should be interpreted relative to a bicycle in an upright riding position on a horizontal surface and that is equipped with the bicycle control device **12**. The terms “left” and “right” are used to indicate the “right” when referencing from the right side as viewed from the rear of the bicycle, and the “left” when referencing from the left side as viewed from the rear of the bicycle. Finally, terms of degree such as “substantially”, “about” and “approximately” as used herein mean an amount of deviation of the modified term such that the end result is not significantly changed. These terms can be construed as including a deviation of  $\pm 5\%$  of the modified term if this deviation would not negate the meaning of the word it modifies.

While only selected embodiments have been chosen to illustrate the present invention, it will be apparent to those skilled in the art from this disclosure that various changes and modifications can be made herein without departing from the scope of the invention as defined in the appended claims. Furthermore, the foregoing descriptions of the embodiments according to the present invention are provided for illustration only, and not for the purpose of limiting the invention as defined by the appended claims and their equivalents.

What is claimed is:

1. A bicycle control device comprising:

a housing member having an attachment part configured to be attached to a handlebar, and a grip part extending longitudinally between a first end of the grip part and a second end of the grip part, the attachment part being provided on the first end of the grip part;

a control lever member pivotally provided with respect to the housing member;

a shift-operating mechanism provided in the housing member, the shift-operating mechanism including a cable take-up member rotatably mounted around a cable take-up axis, the cable take-up member having a control cable attachment part that is configured to be coupled to a shifting device by a control cable; and

a hydraulic fluid pressure generator having a cylinder and a piston movably disposed within the cylinder by movement of the control lever member to generate fluid pressure for controlling a braking device,

the cylinder being disposed in the housing member at a position closer toward the second end of the grip part than the shift-operating mechanism to the second end of the grip part, the cylinder defining a cylinder axis that forms an angle of greater than or equal to  $20^\circ$  and less than or equal to  $50^\circ$  with the cable take-up axis.

## 19

2. The bicycle control device according to claim 1, wherein

the control lever member includes

a first operating lever that pivots around a first axis relative to the housing member for operating the piston, and

a second operating lever that pivots around a second axis for operating the cable take-up member of the shift-operating mechanism, the second axis being different from the first axis relative to the housing member.

3. The bicycle control device according to claim 2, wherein

the cable take-up axis and the second axis are coaxial.

4. The bicycle control device according to claim 2, wherein

the cable take-up axis and the second axis are non-coaxial axes.

5. The bicycle control device according to claim 1, wherein

the cylinder has a cylindrical shape defining the cylinder axis.

6. The bicycle control device according to claim 1, wherein

the cylinder having an open end on a piston side and a closed end on a side opposite the open end, the open end being in a lower position than the closed end when the bicycle control device is in an installed position.

## 20

7. The bicycle control device according to claim 6, wherein  
the closed end of the cylinder is sealed shut by a sealing member.

8. The bicycle control device according to claim 1, wherein

the angle formed between the cylinder center axis and the cable take-up axis is greater than or equal to 25° and less than or equal to 40°.

9. The bicycle control device according to claim 1, wherein

the grip part includes: a first housing section on a side of the first end, and a second housing section on a side of the second end.

10. The bicycle control device according to claim 9, wherein

the grip part includes: a first bracket disposed between the first housing section and the second housing section, and a second bracket housed by the second housing section.

11. The bicycle control device according to claim 9, wherein

the first housing section houses the shift-operating mechanism.

12. The bicycle control device according to claim 9, wherein

the hydraulic fluid pressure generator is disposed above the second housing section.

\* \* \* \* \*